Palynological studies on the Black Mountains.

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PALYNOLOGICAL STUDIES ON THE BLACK MOUNTAINS

SOUTH WALES

THESIS FOR DOCTOR OF PHILOSOPHY

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ABSTRACT

In this study a palynological investigation of blanket peats on Black Mountains reveals a history of the area which is stretching back in time to the Neolithic period , and spanning a period of some 5100 years . The conclusions of this study are as follows : -

CONCLUSIONS

(i) The initiation of blanket mires on Waun Fach is correlated with early Neolithic activity, spreading (on other ridges) in the Bronze age and in the Iron age .

(ii) The intensity of Neolithic and later prehistoric activity was greater in the valleys to the south and west of Waun Fach , than in the Grwyne Fawr valley to the south-east .

(iii) The vegetation of the Grwyne Fawr valley was richer in *Ulmus* and *Tilia* , than the western areas .

(iv) There appears to be a correlation between deforestation and peat initiation . On both Waun Fach South and Waun Fach Central, there are local *Ulmus* declines and *Plantago* sp. appearances about 4500 and 5000 years b.p. , representing Neolithic activity.

At Pen y Gader-Fawr peat initiation occurs later and again there is basal *Ulmus* decline and *Plantago lanceolata* appearance in the late Neolithic / early Bronze age .

Finally on Ty isaf, the charcoal layer immediately below the base of the peat suggests clearances by Iron age man using fire .

(v) Pollen shed theory .

Throughout the profiles of Waun Fach North and Waun Fach South at given horizons , the floral components differ at the two sites , though they are only 90 metres apart. This suggests different pollen sources for each profile , and that pollen - laden winds are channelled up different valleys from different directions .

At the site areas on the plateau top , the winds eddy and shed their pollen . Corresponding differences in site components occur with surface pollen . An aerodynamic or " pollen shed " theory is proposed to account for these data .

(vi) On Waun Fach Central , there appears to be a correlation between the Ulmus decline and the synchronous appearances of Plantago lanceolata .

(vii) Throughout the 5000 years under this investigation the various horizons in the profile reflect land use and provide new insight into THE history of the Black Mountains .

SUMMARY

In a palynological investigation of blanket peats on the Black Mountains a history of the area is uncovered stretching back in time to the Neolithic period, and spanning a period of some 5100 years . Monolith and core samples of the blanket peat were taken at five sites, three on Waun Fach plateau (SO 217300), and one each , on Pen y Gader-Fawr (SO 230285) and Ty isaf (SO 205286)

RESULTS

(1) Waun Fach

On Waun Fach there were three sites, South, Central and North, running over the plateau at 50 & 40 metres intervals respectively.

(a) Waun Fach South Site.

At the South site, the peat is 250 cm in depth and has a basal date of 5127 radio-carbon years b.p. Basal *Ulmus* pollen is about 20 % T.A.P. but is erratic, declines very near the base and *Plantago major-media* appears , therefore , Neolithic activity is evident and is coincident with the initiation of the blanket peat.

Fraxinus has a period of abundance during Neolithic / Bronze age times in response to human activity . There is major deforestation and agriculture in Iron age / Roman times .

(b) Waun Fach Central site .

On this site, the blanket peat depth is 244 cm with no dating. There is a local *Ulmus* decline with *Plantago lanceolata* appearing . The pattern is similar to that on Waun Fach South .

(c) Waun Fach North Site .

Here the peat depth is 250 cm with no dating. Ulmus has much higher levels (up to 40 % T.A.P.), and shows a gradual, stepwise decrease with low levels of Plantago sp. Tilia is much more persistent .

(2) Pen y Gader-Fawr

On the one Pen y Gader-Fawr site the peat depth is 116 cm The radio-carbon date at a depth of 105 cm is 3525 years b.p. In the basal layer Ulmus is already low (7 % T.A.P.) , and Plantago sp. is present. Ulmus recovers, to decline at a depth of 99 cm having an extrapolated date of about 3300 years b.p., i.e. during the Bronze age .

The highest activity (i.e. Plantago sp. peak) is prior to a radio-carbon dated level of 2432 years b.p. at 74 cm , i.e. late Bronze age. The high Tilia may reflect conditions in the Llanbedr valley .

(3) Ty isaf

On Ty isaf (on a ridge west of Waun Fach) , the peat depth is 72 cm. and the date at the 70 cm depth is 2140 years b.p. The charcoal layer below the peat at 78 cm is dated at 2345 years b.p.

Ulmus is low in basal layers and Plantago expands rapidly in the levels above 70 cm , probably reflecting Roman activity. The peak of Plantago (nearly 150 % arboreal pollen) at 35 cm is possibly correlated with agriculture during Norman times.

Note ; see abstract for conclusions .

ACKNOWLEDGEMENTS

In the course of my work on the blanket peats in the Black Mountains, I have been encouraged and helped in many ways. At times, assistance has come from unexpected quarters such as the British Army, who allowed me the use of their helicopter for aerial photographs; or the farmer who loaned me his pony to collect peat samples.

I particularly want to express my gratitude and sincere appreciation to my supervisor, Dr. P.D. Moore of King's College London, whose skilful guidance and continual encouragement have made this research possible.

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I am indebted also to Professor H. Rouse of the University of British Columbia, who placed a laboratory at my disposal during my brief stay in Canada.

Finally I should like to thank all members of my family for their constant encouragement and my friends who accompanied me on some of my field trips into the Black Mountains.

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CHAPTER ONE :

AIMS OF THE INVESTIGATION

1.1 In view of the lack of knowledge concerning the pollen record and vegetational history of the Black Mountains, this investigation was carried out with the following objectives:-

(1) To locate and sample the deepest peat beds over the area in order to obtain records as old as possible.

(2) To determine the general and local vegetational history of the Black Mountains region by means of pollen analysis of the peat beds and of the pre-peat surface.

(3) To establish, as closely as possible, the date of peat initiation on various selected sites and to determine the ages of pollen horizons by means of radio-carbon dating

(4) To relate the pollen record as found in the peat strata to the local archaeological evidence of man's activities in the area.

THE BLACK MOUNTAINS DEFINED

1.2 For the purpose of this investigation , the Black Mountains in South Wales is the massif which makes up the eastern portion of the Brecon Beacon National Park, and which covers an area of some 290 km^2 . The mountains are bordered by two rivers , the Wye to the north and the Usk to the south , both flowing into the lowlands to the east .

The mountain plateau are separated by several valleys which dissect the massif and which run generally north - west and south - east . It is on selected plateaux , blanketed in peat , where sites were established for pollen sampling .

The area of investigation extends into the adjacent valleys and into the lowlands , particularly the Wye lowlands , from which the pollen is carried by the wind .

The prevailing wind is westerly , blowing from the lowlands , but winds also funnel up valleys in easterly directions (see Figure 1.0 , and plate 1.2) .

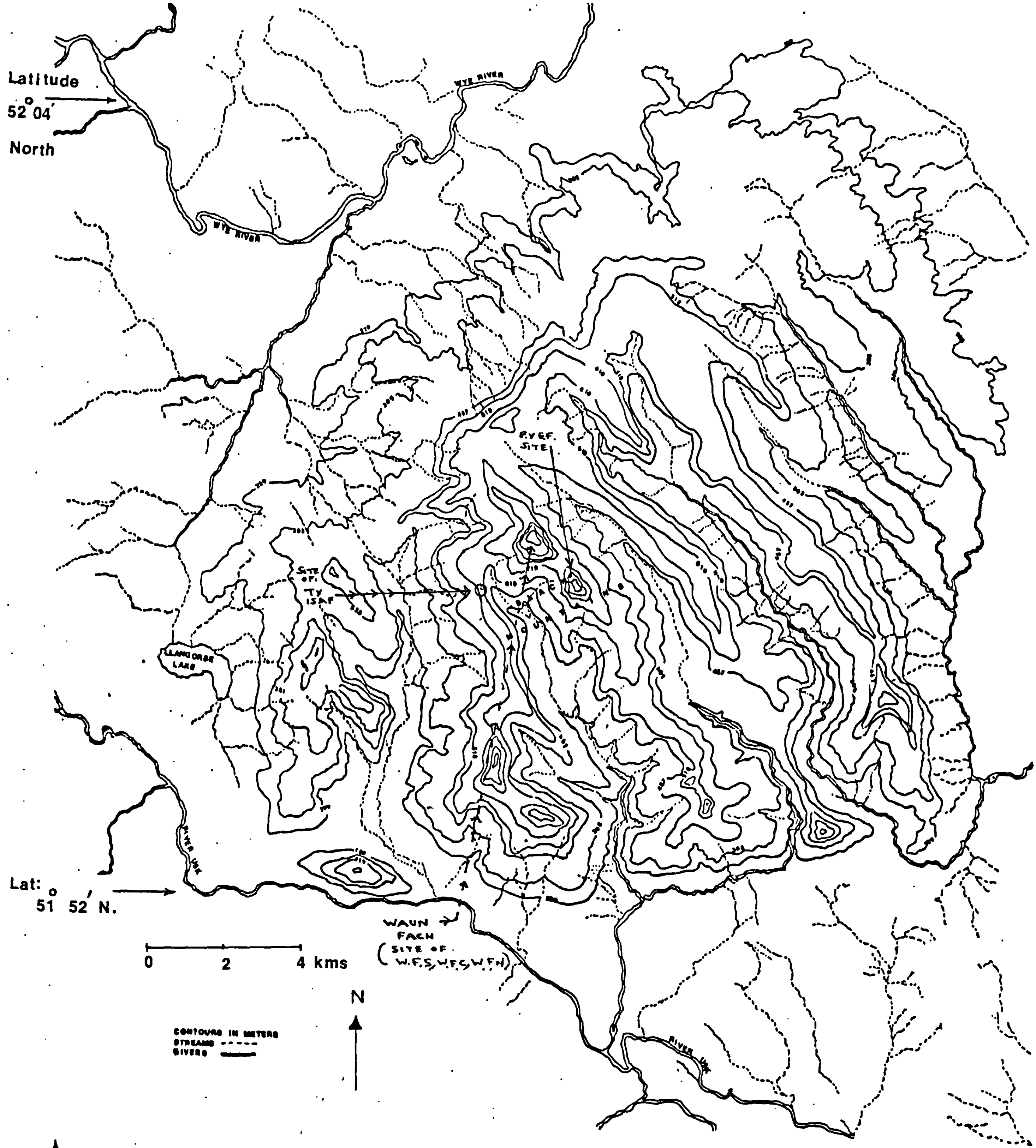


FIG. 1.0

Longitude : 3° 19′ West

THE BLACK MOUNTAINS AND THE SURROUNDING LOWLANDS

SOUTH WALES

Long : 2° 58′ W.

Plate 1.2

Aerial photograph of Llangorse Lake (reverse image) . Near the far bank of the lake is the site of Ty illtud , the most westerly long cairn of the Black Mountains group .

THE GEOLOGY OF THE BLACK MOUNTAINS

THE OLD RED SANDSTONE DEPOSITS

1.3

Before the close of Silurian times much of Britain was affected by strong earth movements that caused uplift and folding. In Wales these movements created an area of upland, "St.George's Land", that occupied much of central and northern Wales George, T.N.(1970). As a result of this uplift, the sea retreated southwards and became restricted to a region running through present Devon and Cornwall where it became the Devonian sea. Between the St. George's Land upland and the Devonian sea to the south there was a tract or embayment. In this bay area terrigenous sediments were deposited as river and deltaic sediments which originated from the detritus eroded from the mountainous hinterland to the north. These sediments were non-marine marls and sandstones and were usually stained a reddish colour by haematite. These constitute the rocks of the Old Red Sandstone, a formation of Devonian age, which merged southwards into the rocks of the Devonian sea.

The Black Mountains and the Brecon Beacons were formed in the embayment area of non-marine deposition. They are composed therefore largely of the rocks of the Old Red Sandstone.

Along the escarpment face of the Black Mountains and the Brecon Beacons red marls are followed by a group of sandstones reaching 580 to 810 metres. in thickness. These formations persist with little change for many miles along their outcrop. They range from siltstones and flaggy mudstones to grits and some conglomerates and form a multi-layered pattern in which coarse and fine beds alternate through many hundreds of units. They can be divided into two distinct formations, the Senni Beds below with dark green chloritic layers interbedded with red, and the Brownstones above (see plate 1.3) .

Plate 1.3

The Black Mountains in winter showing terraces of horizontally bedded Devonian Old Red Sandstone accentuated by snow .

The presence of certain zone fossils (pteraspids) in the Senni Beds places them in the lower Old Red Sandstone. The Brownstones, because of their transitional conformity and diachronous merging with the Senni Beds, are not significantly different in age and are also in the Lower Old Red Sandstone.

Since no representatives of the Middle Old Red Sandstone are known to occur in South Wales, the Upper Old Red Sandstone beds lie with unconformity upon the Brownstone beds beneath. On the Brecon Beacons the Upper Old Red Sandstone is represented by the Plateau Beds which form a table-top cap. These Plateau Beds consist of tough red quartzites which are often conglomeritic. In places the Plateau Beds thin out and are overlapped by the Grey Grits which are clean washed sandstones and pebble beds of river origin. The Brownstones of the Black Mountains are also capped but by another component of the Upper Old Red Sandstone, the Quartz Conglomerate Group , Neville , G.T. (1970) .

CARBONIFEROUS DEPOSITS

When the Lower Old Red Sandstone of the Brecon Beacons and the Black Mountains was in the process of formation from fluviatile deposits, the sea was confined to an area south of the present Bristol Channel. As the Devonian period passed into the Carboniferous, there was a general subsidence on the flanks of St George's Land to the north. The sea then advanced northwards and flooded the freshwater cuvette of the Old Red Sandstone , Neville (1970) . As a result of this gentle marine transgression by the Carboniferous sea, thick deposits of massive limestones were laid down. The Black Mountains remained however above this marine advance and were virtually untouched. It was during this Carboniferous period that the Coal Measures of South Wales were laid down. These consisted almost wholly of terrigenous detritus carried into a shallow subsidiary trough of sedimentation by rivers rising mainly in the north.

GLACIATION

1.4

The only glacial deposits of appreciable size and extent to be found in South Wales , which are younger than the Lias , are superficial deposits of unconsolidated boulder clay and morainic gravel which cover the solid rocks of much of the upland and most of the lowland areas .

These deposits resulted from a Pleistocene period of arctic climate when South Wales was covered by a sheet of ice that finally melted no more than 10,000 to 12,000 years ago , Neville . G . T . (1970) .

It is probable that a main , severe glaciation occured in South Wales prior to 60,000 years b.p. , and that a lengthy period of deglaciation followed , which resulted in the melting of most of the ice .

Glaciation again occured between 30,000 and 20,000 years ago , accompanied by a considerable re-advance of ice , Earp . J . R . and Hains , B.A. (1971) .

During the main glaciation , the region of South Wales was invaded by glaciers originating in the mountains of Wales to the west and north Earp , J . R . and Hains . B . A . (1971) . Ice caps formed on the higher hills and , on increasing size , these caps fed glaciers flowing into lower ground where they coalesced into ice fields .

At maximum glaciation , the valley flanks became submerged and the region eventually was covered by an ice sheet that , in places , was several thousand feet thick , Neville . G . T . (1970) . The movement of glaciers followed the natural outlets along the larger valleys .

In addition to a major movement of ice into the depression of Cardigan Bay , there was a sizeable lowward flow , firstly into the Seven valley in the north-east and secondly to the south-east with a movement of the ice along the Wye valley , Neville , G.T. (1970) .

In the south , ice collected against the escarpment of the Camarthenshire Fans and the Brecon Beacons . Some ice moved into the Usk and joined glaciers from Mynydd Epynt and from the Black Mountains , Neville , G . T . (1970) . There was a similar movement of ice into the Wye valley fron north-west of the Black Mountains . This glacial flow was augmented by ice from the high ground to the west . The resultant ice mass spread out in lobes over the Herefordshire lowlands , Earp , J . R . and Hains , B . A . (1971) .

The Wye glacier in fact , did not submerge or override the Black Mountains , since the valleys of the Black Mountains contain only boulders of local origin. The Usk glacier left morainic deposits and outwash gravels over a considerable area near Abergavenny, Earp , J . R , and Hains , B . A . (1971) .

The last melting glacial remnants appear to have disappeared at about 10,000 years b.p. , Walker M.J.C. (1980) . The Black Mountains were located on the eastern portion of the Breknockshire (Breconshire) drift , Lewis C.A. (1970) . The classic "U" shaped Rhian goll valley profile demonstrates a south moving glacier . Morainic drift deposits located in the valley near Crickhowell , support this view , Webley D.P. (1961).

The blanket peat deposits on the Black Mountains probably mask any effects of glaciation at higher elevations . Probably only the highest peaks of Waun Fach and Pen y Gader-Fawr were spared from any ice sculpturing , Neville G.T. (1970) . The Sheltered Grwyne Fawr valley appears to have been spared from any glacial movements, judging by its narrow " V " shaped profile , (see Figure 6.110) .

CLIMATE

1.5

The Black Mountains may be said to have an Atlantic climate since the relatively warm water currents and the mild air off the west coast of Wales have the effect of producing cool summers and mild winters. July and August are the warmest months, while February is the coldest, (H.M.S.O.1971). As in other parts of Britain, there is a marked difference between upland and lowland areas. When the weather front carries cool cyclonic air from the polar regions, the elevated areas are coolest, while under dry warm calm anti-cyclonic conditions, the uplands suffer less compared with the lowlands, Shorter , Ravenhill, Gregory (1969). In general, in the Black Mountains temperatures decrease with increasing altitude and precipitation increases. The prevailing winds are the westerlies which bring in moisture-laden air from the Atlantic. The high exposed peaks and the northern escarpment are often shrouded in black cloud. It may be for this reason that the mountains are called the Black Mountains .

The rainfall in the Black Mountains region is mainly orographical since moisture laden winds, on striking the mountainous area, are forced to higher elevations where cooling, condensation and precipitation occur. From the isohyets maps of Wales generally and the Black Mountains in particular, it will be seen that there is a definite relationship between precipitation and altitude. (Figs. 1.1)

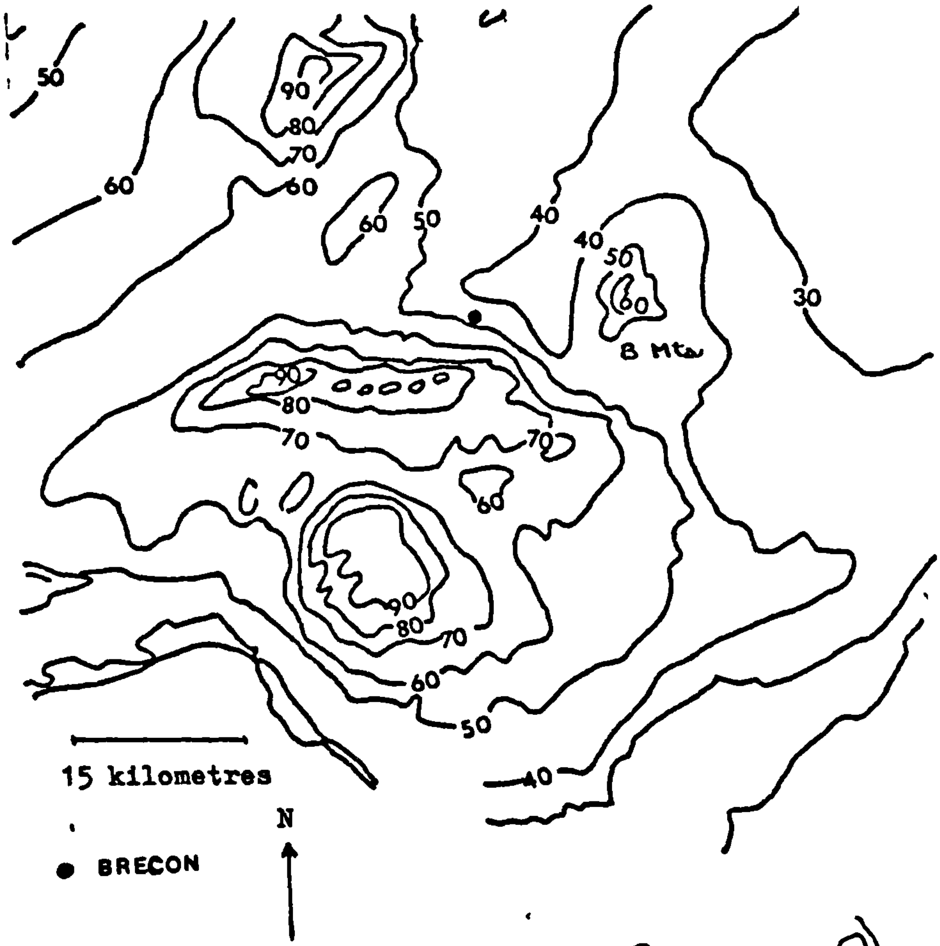
The Black Mountains, with an average annual precipitation on the peaks of 1.76+ metres ~~ms.~~ lie in a partial rain shadow of the Brecon Beacons, where the precipitation can reach 100 inches a year. Table 1.1, shows precipitation recordings for a one year period. The meteorological station where these recordings were made is located at 810 metres on the highest peak, Waun Fach.

It is here that rainfall is heaviest . Streams from Waun Fach and from other neighbouring peaks feed into the Grwyne Fawr reservoir . From Table 1.1 , it will be seen , that January and February , are the wettest months with precipitation reaching 34 cms.

FIGURE 1.1

ANNUAL PRECIPITATION MAP OF THE BRECON REGION

After D.P. Webley .



Isohyet lines in inches .
(1 inch = 24.2 mm)

1 : Black Mountains Area .

TABLE 1.1

WAUN FACH , BLACK MOUNTAINS RAINFALL DATA

Year	Jun	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1974	343	202	86	19.5	108	106.8	139.2	150	235	100	150	124	1763.5
1975													
1976					92								
1977						71	111	196	70	148.8	180	218	
1978	325	309		150									

NOTE : Rainfall in millimetres .

From Welsh National Water Development Authority .

CHAPTER TWO

METHODS AND TECHNIQUES

2.1 The methods employed in this investigation involved the use of aerial photography of the region; a survey of the Black Mountains' peaks by helicopter; the use of Ordnance Survey maps and Land Use maps (Coleman 1967), and detailed field work in which steel probes provided the means of determining the depth of the peat beds.

Forty aerial photographs in stereoscopic overlapping pairs were used to obtain three dimensional views. This technique provided an excellent composite picture of the topography of the area in which it was possible to pick out prominent features and changes in the colouration of the vegetation.

In addition, photographs of given areas were examined and compared with the vegetation in the field in the same areas. This was done over each of the selected sites and details of peat distribution were transferred by eye to Ordnance Survey maps, from which diagrams were made (see Figs, 2.1,2,3). A similar method to this was used by Simmons (1963).

Land Use maps of the Black Mountains' peaks were used to make rough groupings of plant communities. (Fig , 3.8) .

Accurate measurements of peat depth were made in the field by means of two steel probes, one 2 m , in length and the other 3 m , The diameter of both probes was 0.55cm. One end of each probe was sharply pointed while the other end was curved into a handle. Each probe was etched along its length at centimetre intervals.

Before commencing the actual measurements, random depth probes were made over the whole of the Black Mountains range to ascertain the deepest areas on each peak plateau for systematic probing. Some of the peaks were reached in this preliminary survey by a British Army helicopter kindly placed at my disposal by the Army Base on Salisbury Plain .

The area to be probed on each plateau was first marked out on maps , and , probes were made at intervals of 20 and 30 metres along the long axis of the plateau .

Transect lines were marked out at each interval and further probes were made on these cross lines at , 5 , 10 , or 15 metres spacings . The length of each cross line depended on the contour. No probing was done below the 615 metres contour line , since , at this level , the peat deposits were too shallow . At each probing point , peat depths were recorded from the calibrated probe rod , (see Figures , 2.1 , 2.2 and 2.3) .

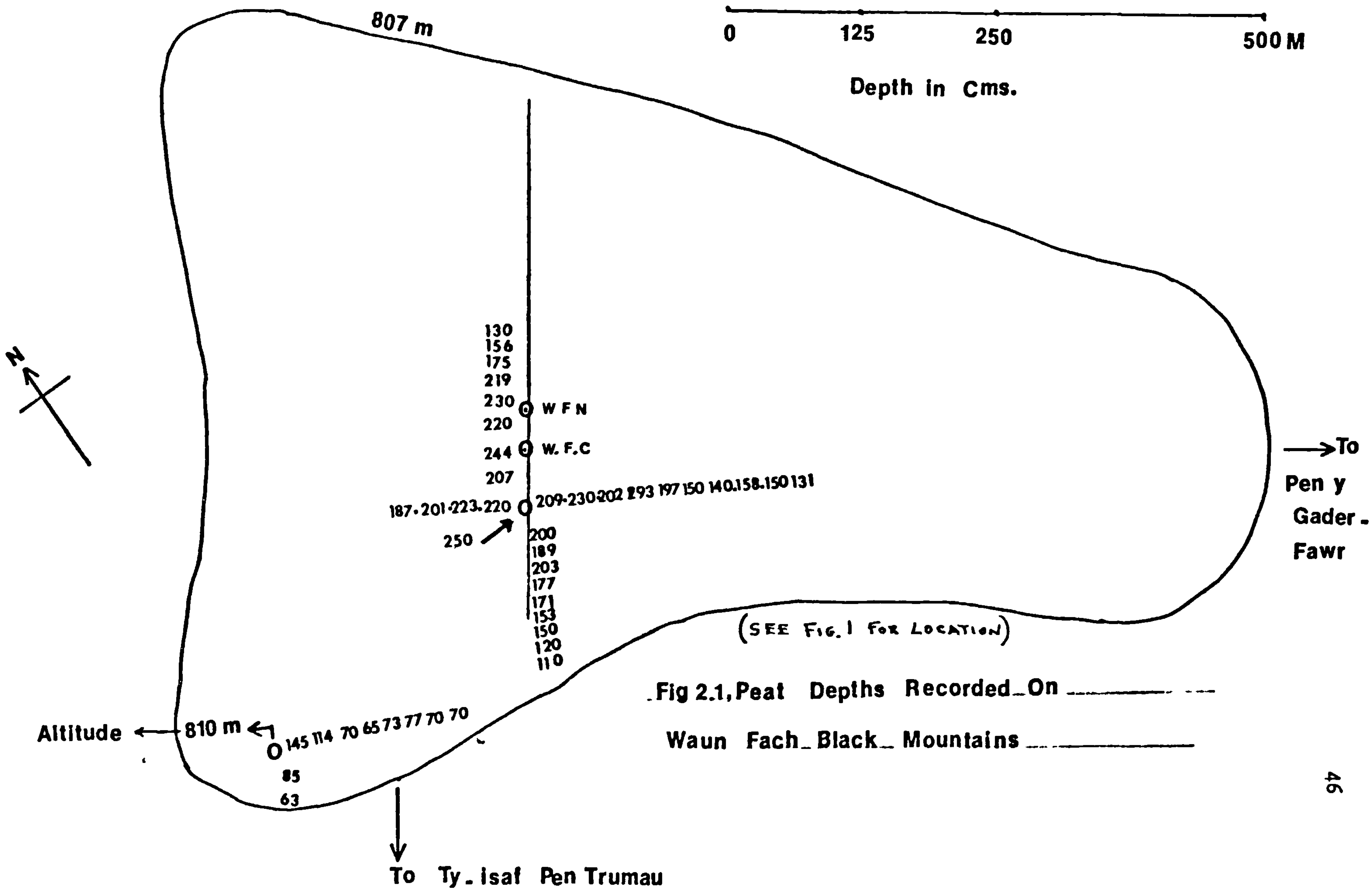
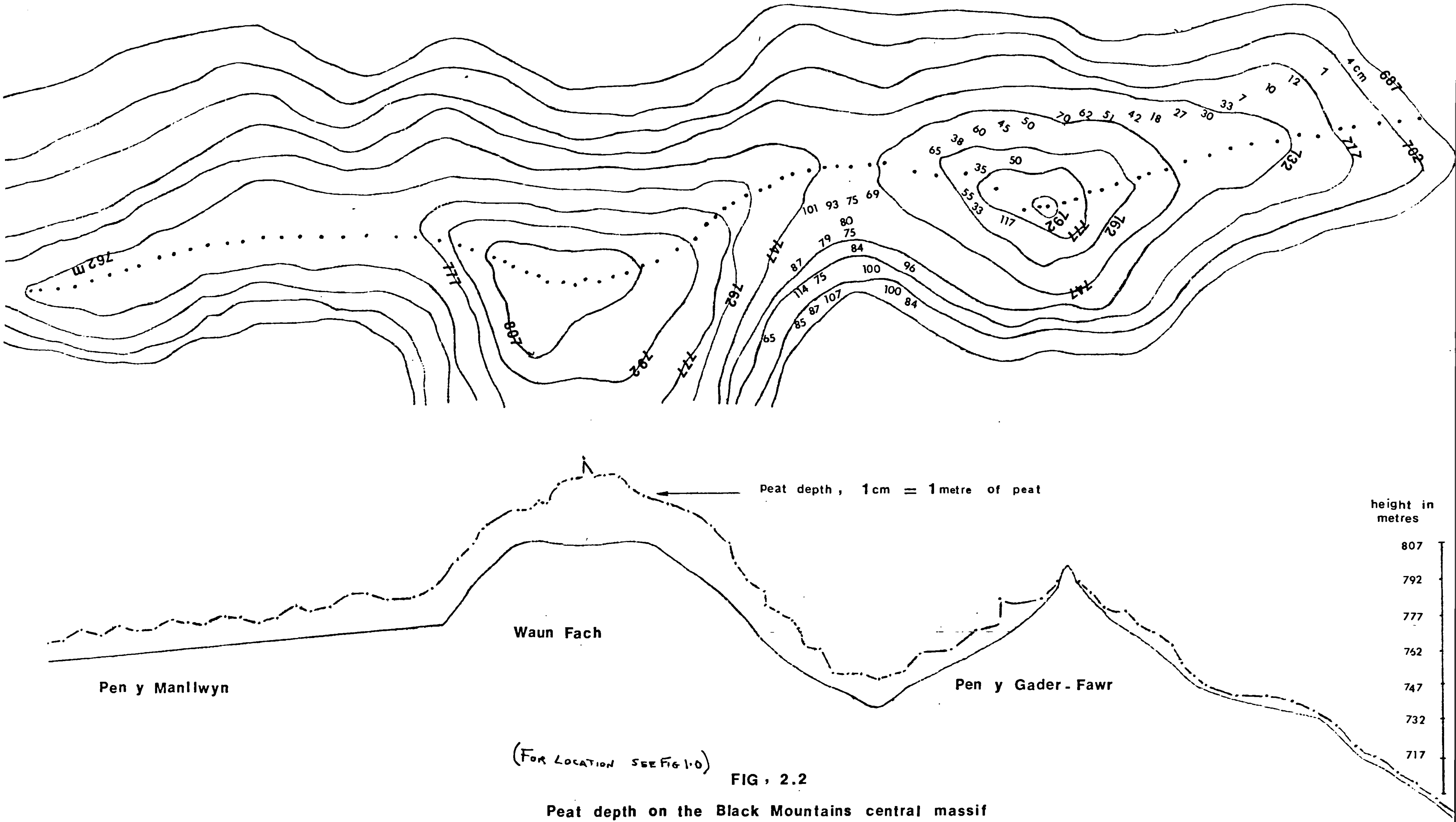


Fig 2.1, Peat Depths Recorded On
Waun Fach Black Mountains



(For location see Fig 1.0)

FIG , 2.2

Peat depth on the Black Mountains central massif

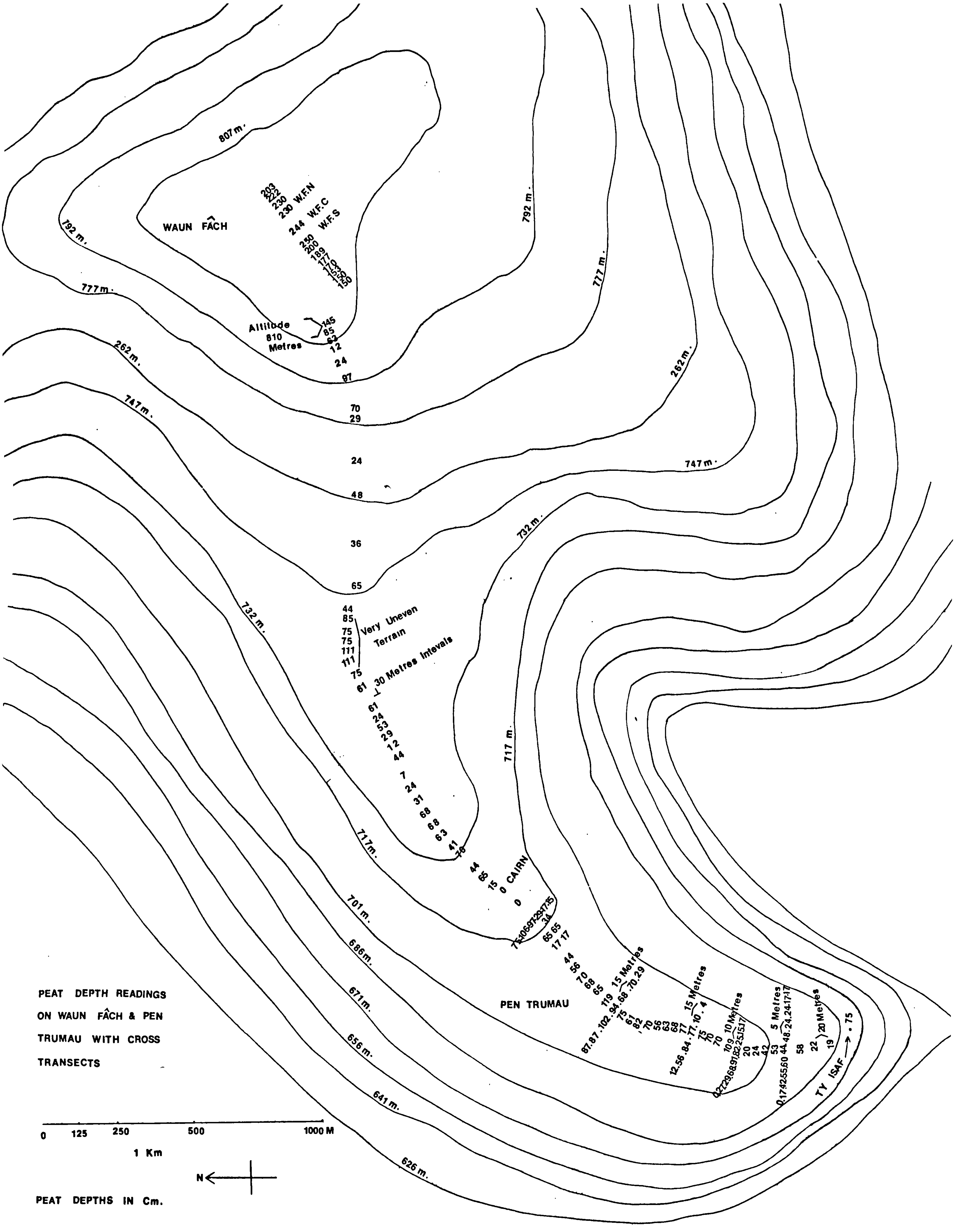
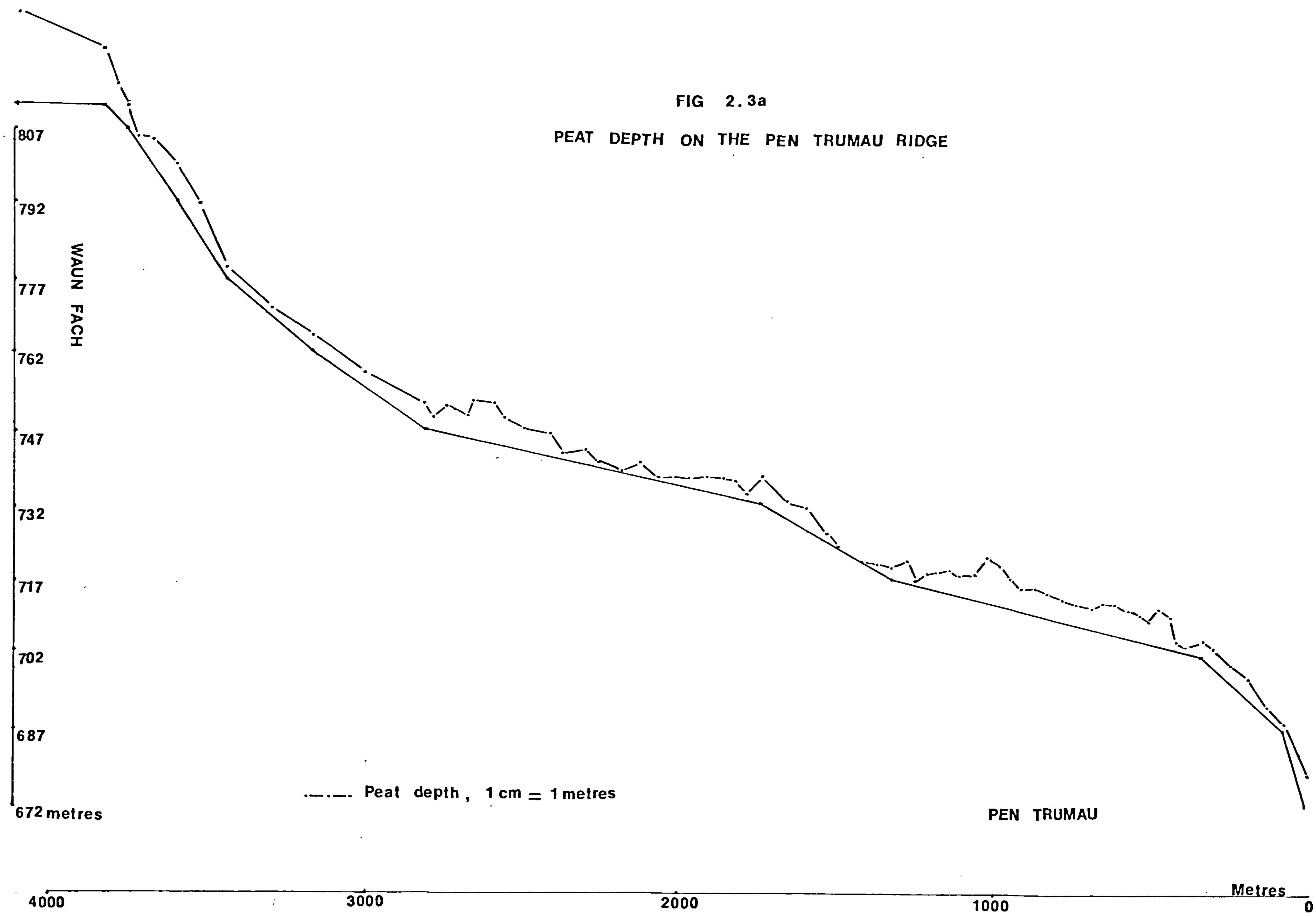
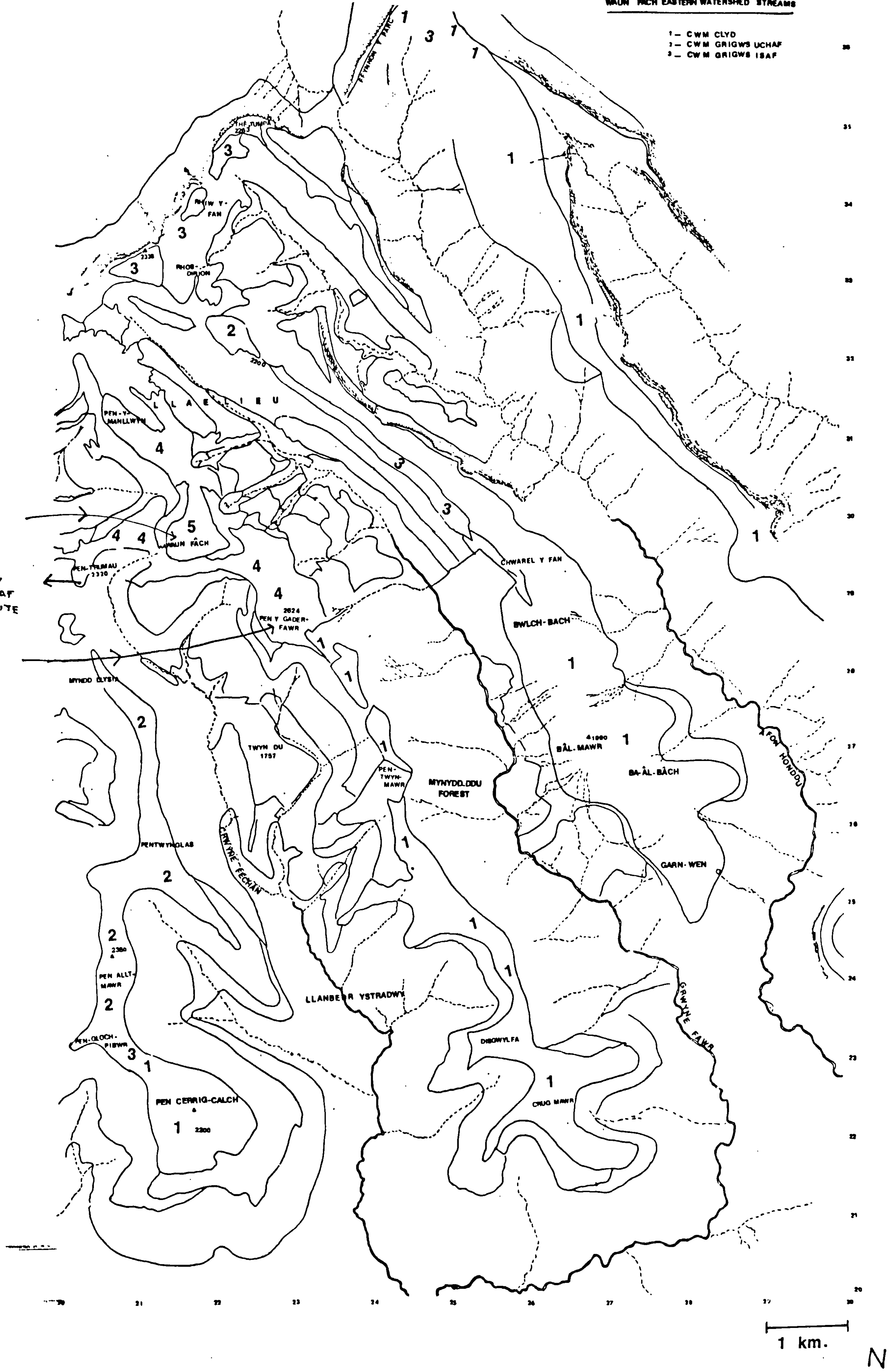

WAUN FÂCH
W.F.N
W.F.C
W.F.S
Altitude 810 Metres
Very Uneven Terrain
30 Metres Intevals
CAIRN
PEN TRUMAU
15 Metres
10 Metres
5 Metres
20 Metres
TY ISAF
807 m.
792 m.
777 m.
262 m.
747 m.
732 m.
717 m.
701 m.
686 m.
671 m.
656 m.
641 m.
626 m.
PEAT DEPTH READINGS ON WAUN FÂCH & PEN TRUMAU WITH CROSS TRANSECTS
0 125 250 500 1000 M
1 Km
N
PEAT DEPTHS IN Cm.

FIG. 2.3

FIG 2.3a

PEAT DEPTH ON THE PEN TRUMAU RIDGE





FIG, 2.4 : GENERAL PEAT DEPTHS ON BLACK MOUNTAINS

1. 0 – 20 cm.
2. 20 – 40 cm.
3. 40 – 60 cm.
4. 60 – 150 cm.
5. 150 – 250 cm.

RESULTS

2.2 The areas of blanket peats on the Black Mountains can be divided into several distinct components based on geographical location and altitude. These components may be described as follows:-

(1) The Waun Fach and Pen y Gader-Fawr massif with three lobe extensions; one curving away from Waun Fach, 810m altitude, in a westerly direction to Pen Trumau, 707m altitude; the second, also from Waun Fach, in a northerly line to Pen y Manllwyn, and the third, a short southerly extension from Pen y Gader-Fawr to Pen-tŵyn-mawr. (See Figs. 2. 1,2,3) .

(2) The second component lies to the west and roughly parallel to (1) and (3) . It may be termed the western ridge and is a long tongue running from Mynydd Llysiau in the north to the calcareous Pen Cerrig-calch , 701. m altitude , in the South (see Fig. 2.4) .

(3) The third component continues southward from Pen-tŵyn-mawr , (661 m altitude), in a series of saddles and peaks of diminishing height to terminate in the peak, Crug Mawr , 550. m altitude (see Fig. 2.4) .

(4) The fourth component again is parallel to (1) and (2) and lies to the east. It commences with the peak, Twyn Tal-y-Cefn (across the valley from Waun Fach), then runs southwards as a ridge to Bal-Mawr , (607m altitude).

(5) The fifth component, Darren Lwyd , is another parallel ridge, short in length, to the east of (4) , (see Fig. 2.4) .

(6) A sixth tongue of high land lies to the east of (5). It commences in the north with the peak Ffynnon-y-Parc, 677m altitude, and extends southwards along the line of Offa's Dyke (see Fig. 2.4) .

(7) Finally, the seventh component is the northern escarpment which forms the northern boundary or palm from which all six components hang like a six-fingered hand, (See Fig. 2.4) .

The peat beds associated with these seven component areas are as follows:-

(1) <u>The Waun Fach , Pen y Gader-Fawr Massif</u>

This massif embraces the flattened ridge or plateau areas on Waun Fach (810 metres in elevation) and Pen y Gader-Fawr (800 metres in elevation), together with an inter-connecting saddle area. Peat depths range from 1 metre in the saddle to 2.5 metres on the Waun Fach plateau. The peat deposits run in a magnetic north-south direction. From the air, this peat belt region, with its eroded edges along the lower contours, looks very much like a long blanket, (See Fig. 2.4 and plate 2.44)

Three lobes radiate from the massif in branch deposits of shallower peat with the depth of peat decreasing with distance from the central area. These shallower deposits are more recently formed as indicated by radiocarbon dating. The Pen Trumau ridge with a maximum elevation of 707 metres is a western extension from Waun Fach. On this extension the peat beds may thin out to a few centimetres in depth on the narrowest ridge. It is from this extension that the Ty isaf core was taken from a pocket of deep peat 0.75 metres deep. The area of this western lobe is approximately 25 hectares. The second lobe, the Pen y Manllwyn lobe is approximately 762 metres in elevation and extends for a distance of about 1.5 Kilometres to the northern escarpment. Peat depths decrease on this lobe from just over a metre at the southern end to 67cm in the north.

Plate 2.45 : Aerial photograph from north-west , showing ; (1) Pen y Gader-Fawr summit . (2) Waun Fach plateau. (3) the Pen Trumau ridge. Between 1 & 2 see peat depth Figure 2.2 . Between 2 & 3 see Figures 2.3 & 2.3a .

Plate 2.44 : Aerial photograph of Pen Trumau from the South-west, showing ragged peat hags on margins of blanket peat. The upper right of the photo , shows slopes of Waun Fach. Peat depth on ridge crest, (see Figures 2.3 and 2.3a) .

The third lobe extends southwards from Pen y Gader - Fawr and here peat depth decreases rapidly towards the south . In places rock outcrops are common , (see Plate 2.45) .

Particular attention was given to these high elevation peats , the depths are recorded in figures , 2.1 , 2.2 and 2.3 . All pollen profiles came from this area , and they are as follows :

Waun Fach South , Waun Fach Central , Waun Fach North , Waun Fach western lobe , Pen Trumau (pollen core , Ty isaf) , and Pen y Gader - Fawr .

2nd to 7th peat components :

Comparatively shallow peats cover most of the remaining components , figure ,, 2.4 , show peat locations in the various areas .

FACTORS AFFECTING PEAT DEPTH ON THE BLACK MOUNTAINS

2.3 Peat depth is determined by combinations of a number of factors , the most important of which are altitude , precipitation , topography , climate, biota , nutrients , soil and the nature of the bedrock .

ALTITUDE AND PEAT DEPTH

2.31 On the Black Mountains peat depth generally increases with altitude, thus the deepest peats were found on Waun Fach which has an altitude of 810 metres, (see Figures 2.2 & 2.3) . It is at this altitude that we have the heaviest precipitation (1452 mm. plus) , with relatively low evaporation because of the lower temperatures which prevail at this height . In addition this Waun Fach plateau and the plateau of Pen y Gader - Fawr , form broad flattened areas , which are ideal bases for peat formation .

At lower altitudes peat DEPTH generally reduces . Taylor and Tucker (1968) , found that 90 % of the peat deposits in Wales lie above 305 metres . All Black Mountains peat beds examined are more than twice this altitude . Blanket peats can occur however at lower altitudes. Cardiganshire blanket peats were found at 183 metres altitude by Smith R.T and Taylor (1969) , and at 228 metres altitude by Moore P.D. and Chater E.H. (1969) ., (see Plate 2.42) .

Plate 2.42

This plate shows a shallow Eriophorum sp. blanket peat (60 cms.) on a flat broad ridge at an altitude of approximately 630 metres. This deposit is located between Pen Cerrig - calch and Pen Allt - mawr . Also shown are occasional surface pools and the uneven nature of the surface partly due to trampling(in foreground) .

TOPOGRAPHY AND PEAT DEPTH

2.32 Although altitude and precipitation are vital factors in blanket peat formation, these factors must combine with others to ensure peat accumulation. Thus on Waun Fach and Pen y Gader-Fawr elevation and precipitation are combined with relatively level surfaces, which retain moisture and peat deposits are relatively deep. Towards the edges of each plateau the ground begins to slope downwards, water run-off increases and water retention is decreased. On plateau shoulders as well as on narrow ridges, therefore, peat beds thin out and become shallow, even though rainfall is high. Conversely, where there is a saucer-shaped depression in the flat plateau area, as on Waun Fach, peat depths were found to increase due presumably to more efficient water retention. Thus topography plays an important part in determining peat depth. Fig. 2.3a shows peat depths over the Pen Trumau ridge (an extension of the Central massif , Waun Fach) . It can be clearly seen how there is a tendency for peat depth to increase as the slope angle decreases .

THE NATURE OF BEDROCK AND PEAT DEPOSIT

2.33 Another necessary factor which can affect peat formation is the type of bedrock which peat can accumulate . The long western ridge of the Black Mountains terminates in an extensive broad slightly rounded peak . This peak , Pen Cerrig calch , has a formation in which the Devonian old red sandstones are overlain by carboniferous limestone and Millstone Grit (section 1.4) .

Peat is thin on this peak with many areas of exposed bedrock . This can be seen in plates 2.43 and 3.3 . The bedrock often fragments into coarse calcareous boulders . This uneven , well drained , nutrient-rich surface is therefore , not the most likely location for peat deposits .

However , peat has been found to accumulate on calcareous deposits in the western portion of the Brecon Beacon national park , on the Black Mountain , Smith , A . G . (1979) , (personal communication) .

The great majority of all Black Mountains ridges and plateaux are composed , however , of Devonian sandstones ; yet peat can be sparse and its depth varies from 1 cm. to 25cm .

Plate 2.43

Limestone outcrops on a southern peak of the Black Mountains (Pen - Cerrig-calch) , SO, 217224 .

AGE OF DEPOSIT AS A DETERMINANT OF PEAT DEPTH

2.34
Three peat profiles have been radio-carbon dated. They are, Ty isaf, Pen y Gader-Fawr and Waun Fach South. The radio-carbon dates for peat initiation on these profiles are 2345 ± 70 years b.p. ; 3876 years b.p. and 5127 years b.p. (extrapolated dates) .

The depths of these three profiles are 78 cm and 116 cm and 250 cm respectively. From the above data it can be seen that peat depth here is an indication of the age of the deposit. Many other researchers have found that some shallow peats can be older than the deepest of the Black Mountains. Table 2.1 , shows clearly , that , the age of a deposit is not the only factor which determines peat depth.

TABLE 2.1

Showing several profiles of similar age and varying depths.

Area	Peat depth cm	
North-Wales Cardigan - shire	190 cm	Moore P.D. (1968, at Plynlimmon),
North - Pennines	150 cm	Chapman S.B. (1964, Coom Rig B, North - Pennines)
South - Pennines	150 and 185 cm	Tallis J.H. & Mcguire J. (1972, from Lanca - shire)
South - Pennines	190 cm	Bartley D.D. (1975, Rishworth Moor , South - Pennines)
South- Pennines	170 cm	Hicks S.P. (1971, Hipper Sick, South ennines)

Dates of all profiles ; 5000 years b.p. or greater .

DRAINAGE , EROSION AND PEAT DEPTH

2.35 The ability of a blanket bog to retain water will determine growth and thus peat depth . A high retention is advantageous since it ensures anaerobic conditions in the preserved peat areas beneath the living surface carpet .

If there is desiccation through drainage and evaporation , then aerobic organisms can attack the preserved peat and thus cause decomposition . This would have the effect of reducing blanket peat formation and thus would reduce depth .

Water , draining off a blanket bog , can have significant erosive effects . This was indicated during field trips to the Saddle region(Gader), between the Waun Fach and Pen y Gader - Fawr summits .

Thick hags of peat (up to 100 cm thick) were observed to be actively eroded by surface run off . The erosional effects of drainage are most clearly seen from the air ..Plates 2.44 shows a jagged line of eroding peat on the margins of a blanket bog . This is located at the northern head of the Llanbedr valley .

CHAPTER THREE

CHAPTER THREE

SURFACE POLLEN STUDIES - OBJECTIVES

3.0 The principal object of this reasearch in the Black Mountains , is to relate fossil pollen results to past enviroments and to ancient vegetational patterns in the surrounding areas . Similarly the present - day investigation is to determine how closely surface pollen records reflect the living enviroment . It is also the object to compare existing records with the fossil pollen picture , assuming that fossil pollen reflects its surroundings in a similar way to present day surface pollen .

In addition to these objectives there is a further reason for surface pollen studies . In the fossil pollen profiles on Waun Fach , it was found that the pollen , which arrived at two neighbouring sample sites (Waun Fach South and Waun Fach North) , came from totally different geographical locations even though the two Waun Fach sites are only 90 metres apart .

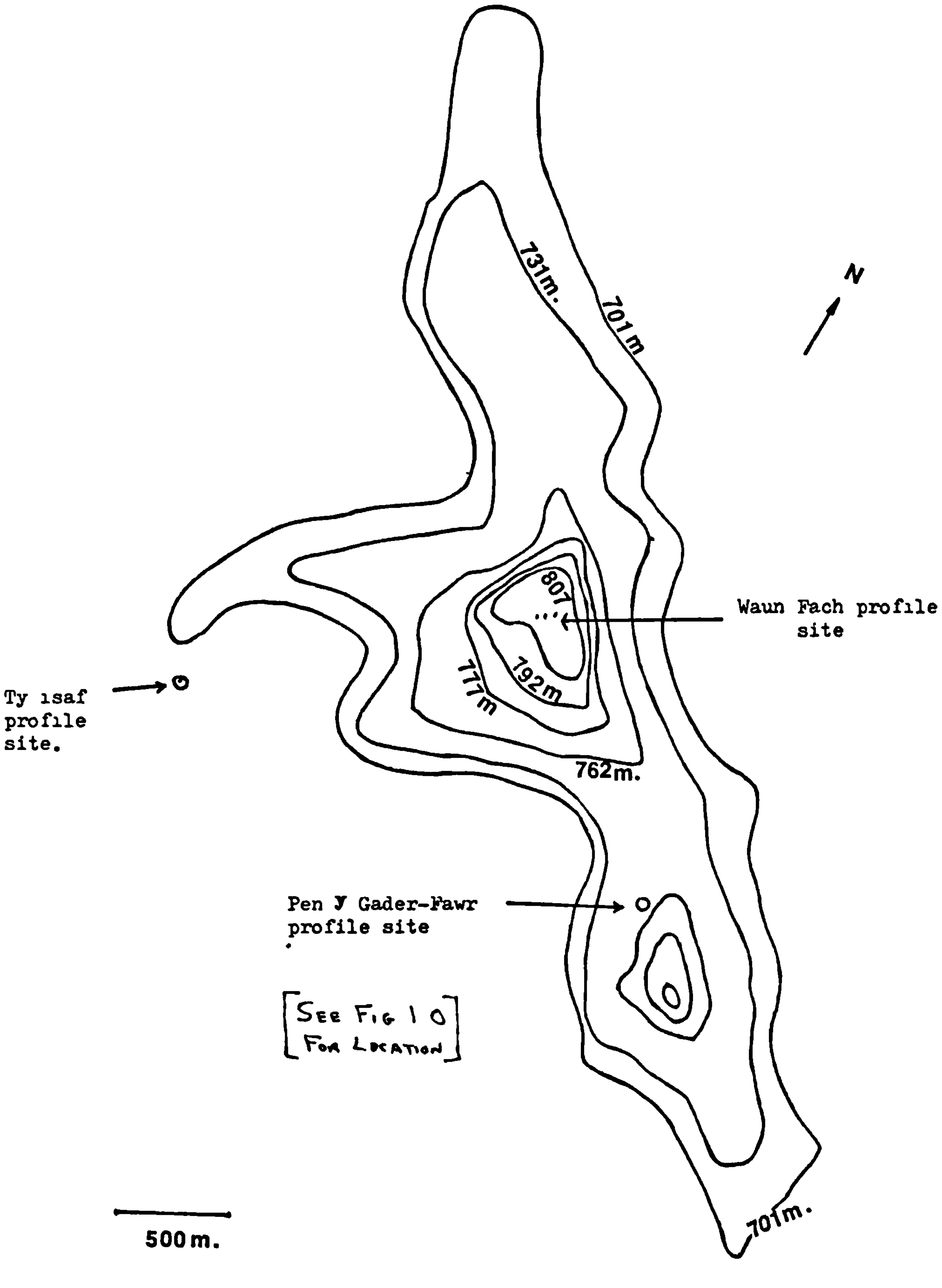
The idea of a "pollen shed" effect is advanced to explain this phenomenon (see section 6.110). The additional objective of this surface pollen study is to indicate therefore , that this "pollen shed" phenomenon exists to-day .

SURFACE POLLEN STUDIES - METHODS

3.1 (a) Sampling sites :

In order to learn more about the pollen shed effect the numbers of sampling sites on Waun Fach were increased from 3 to 10 . The new sample points were spaced along the same transect line as the original three sites . The transect line now extends for a distance of about 250 m. across the flat area of the Waun Fach plateau in a straight line running south-west to north-east , sampling sites are shown on Figure 3.5 .

Figure 3-5 · Location of the Black Mountains pollen profiles .



The location of the 10 Waun Fach sampling sites is shown on Fig 3.4. The original sampling sites on Ty isaf and on Pen y Gader - Fawr were also used for surface pollen counts (see FIG 3.5) .

SURFACE POLLEN SITES - METHODS

3.2 (b) Sampling methods :

Surface pollen was collected from the top half centimetre of peat on the Black Mountains plateau . This was taken to represent recent pollen rain over a period of from one to five years .

The idea of using a man-made pollen traps was considered but was discarded for several good reasons . Firstly , because marker stakes had been stolen and any pollen trap was likely to disappear in the same way . Secondly , the collection of pollen and spores in the first half centimetre provides similar conditions to those on previous mire surfaces in terms of reception , retention and preservation .

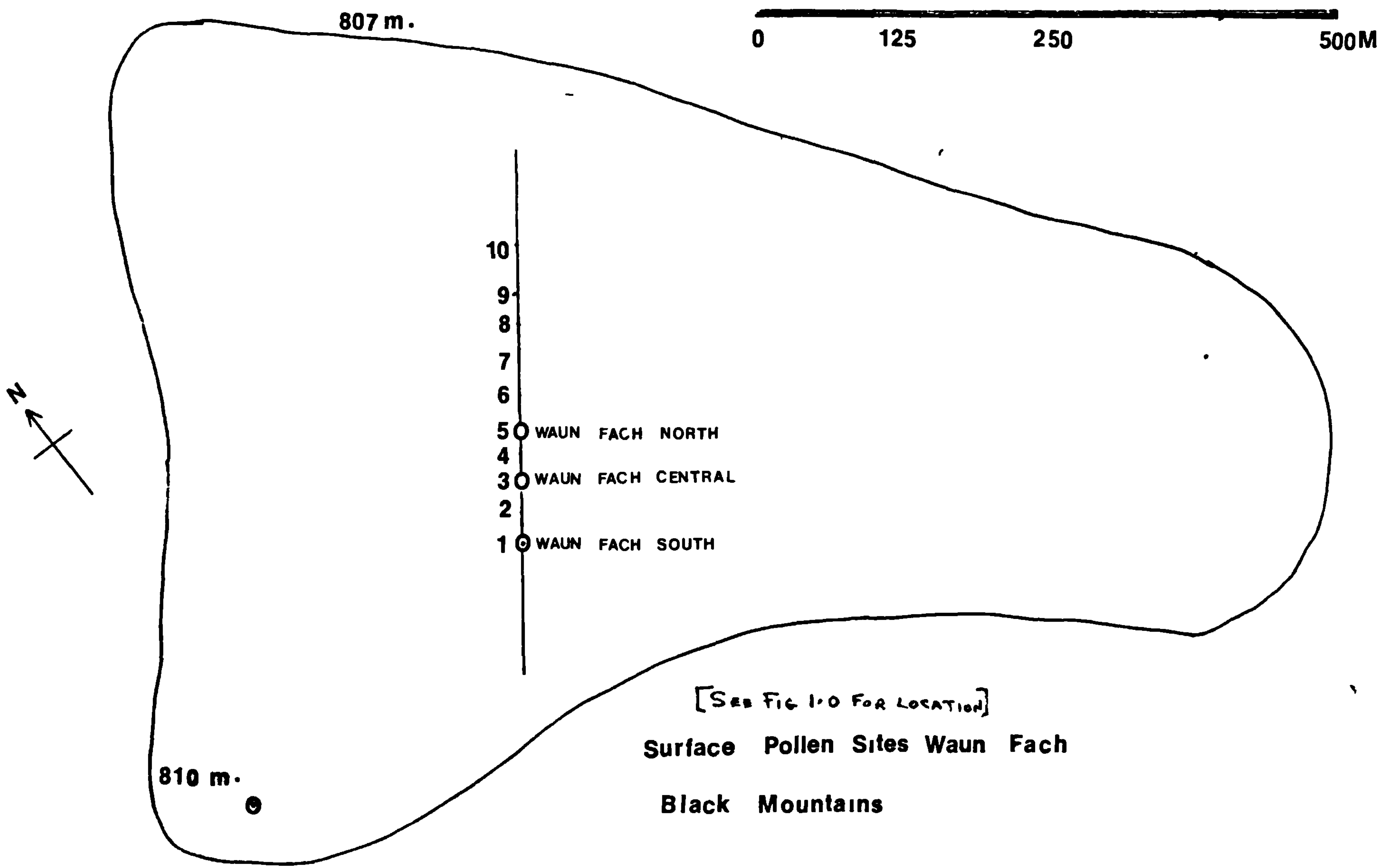
Thirdly , pollen rain may be uneven over an area in a short period of time because pollen from a stand of vegetation may be deposited in different places in different years, Ludi (1947) . Over a relatively longer period of time , irregularities in pollen distribution will tend to even out .

SURFACE POLLEN STUDIES - METHODS

3.3 (c) Surface pollen extraction and slide preparation procedure :

The procedure for the extraction and preparation of surface pollen samples was the same as for fossil pollen samples , except that no hydrofluoric acid

FIG , 3 4



[See Fig 1.0 for location]

Surface Pollen Sites Waun Fach

Black Mountains

treatment was needed (see section , 4.71) . In preparing the samples for extraction blocks , a few centimetres deep , of the peat surface were cut after clipping away any surface grasses and weeds .

From each block the top half centimetre was removed by slicing carefully with a very sharp scapel . Generally the pollen was found to be in a good state of preservation . The Ty isaf sample showed the greater signs of erosion , but this did not prevent identification .

SURFACE POLLEN STUDIES - RESULTS

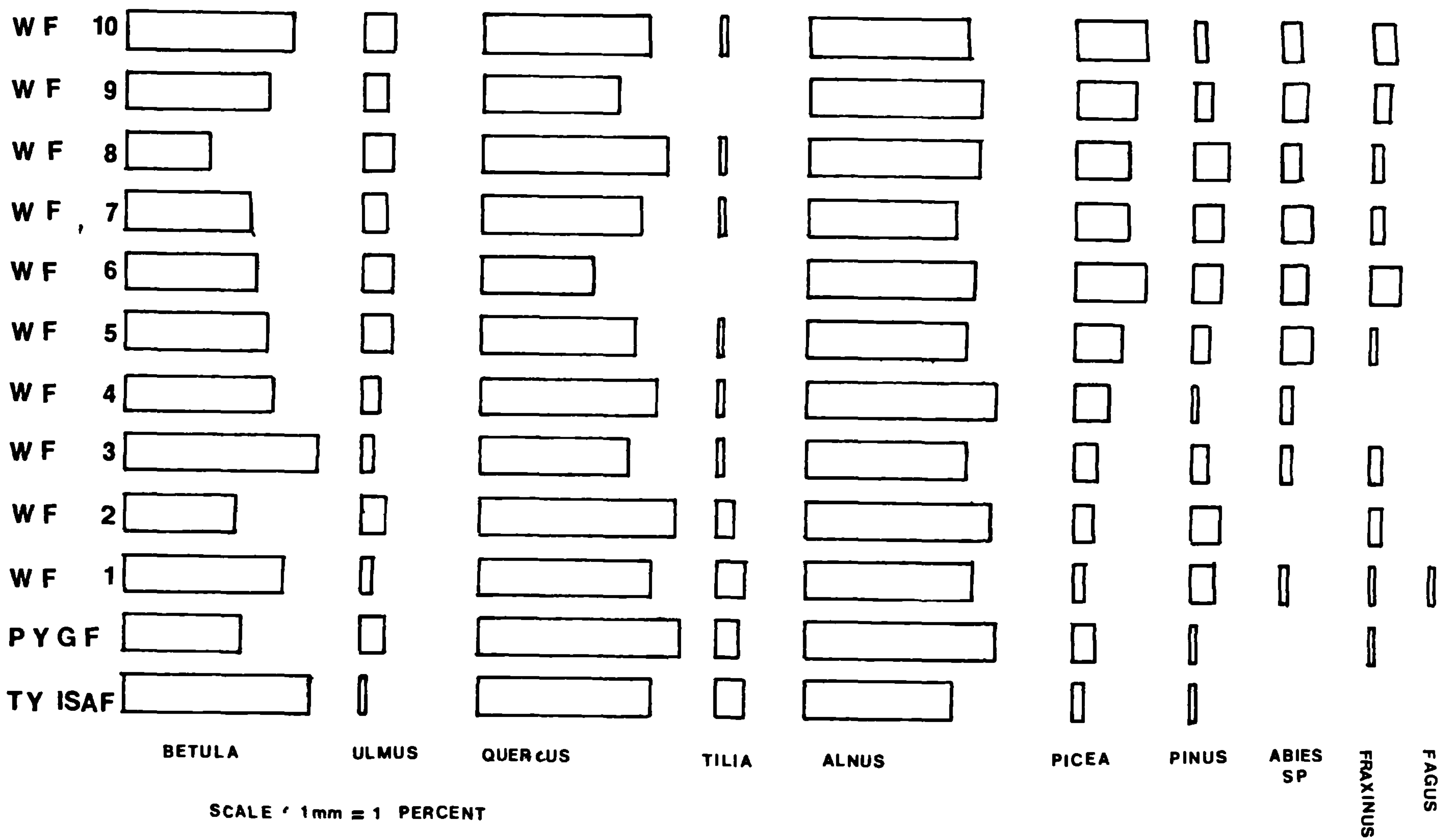
3.4 The results of the surface pollen counts are shown in Figures 3.1, 3.2 and 3.3 . In these figures , P.Y.G.F. is Pen y Gader - Fawr ; W.F.S.1 is Waun Fach South ; W.F. is Waun Fach ; W.F.C. 3 is Waun Fach Central and W.F.N. 5 is Waun Fach North .

WAUN FACH RESULTS - GENERAL

From the results of the ten Waun Fach surface samples , as shown in Figure 3.1 , some interesting arboreal trends are observed . Picea has decidedly higher T.A.P. percentage values in the north-eastern end of the Waun Fach sample transect ; i.e. on site Waun Fach 4 , to Waun Fach 10 , T.A.P. percentages range from 6 % to 12 % as compared with 2 % to 4 % for sites Waun Fach 1 , to Waun Fach 3 inclusive (Fig. 3.1) .

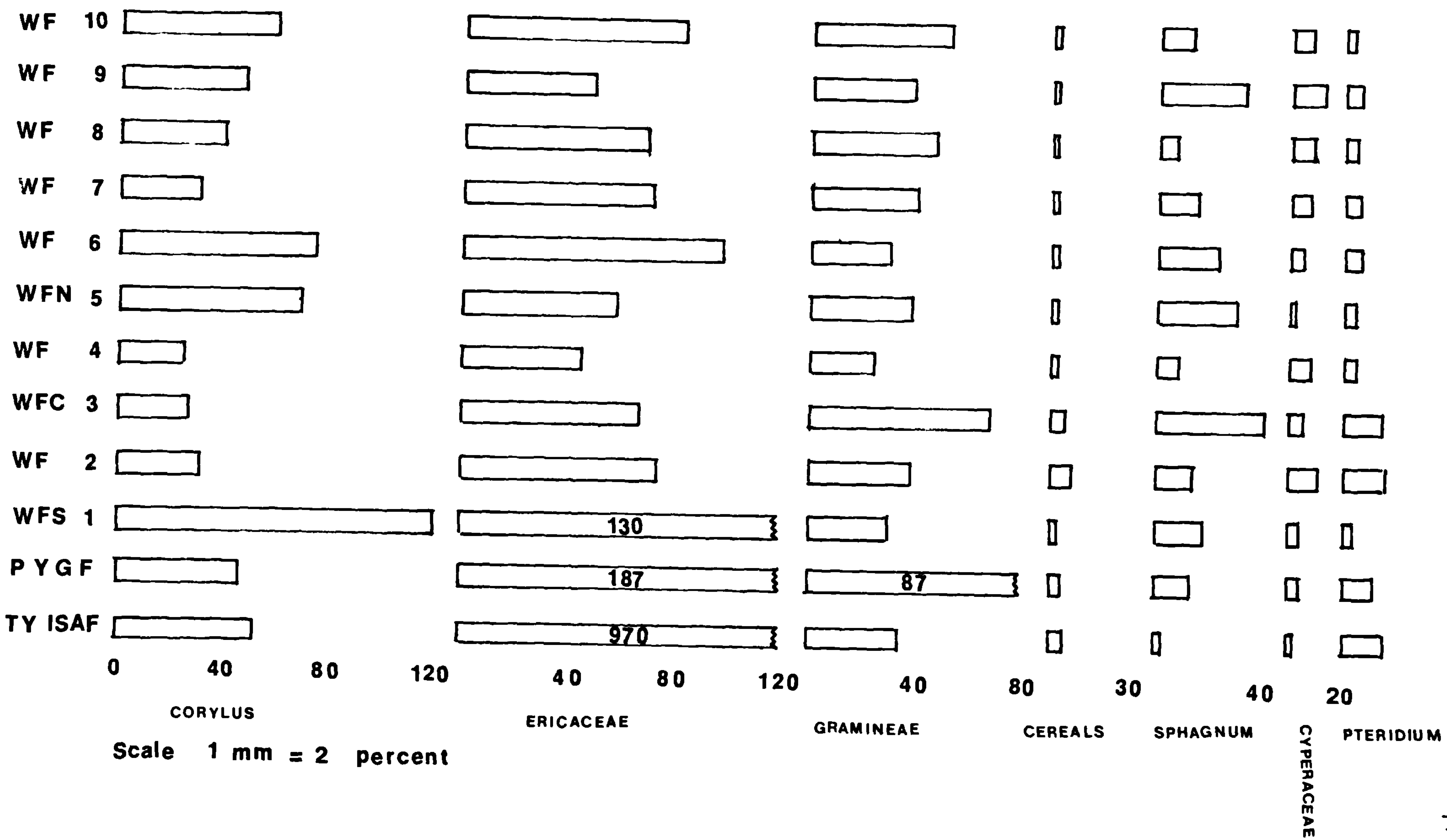
Abies shows a similar trend with generally higher T.A.P. readings on sites Waun Fach 5 , 6 and 7 . With Pinus also the higher T.A.P. % tend to appear at the north-east end of the transect .

FIG, 31, SURFACE POLLEN FROM THE BLACK MOUNTAINS, PERCENT OF TOTAL ARBOREAL POLLEN

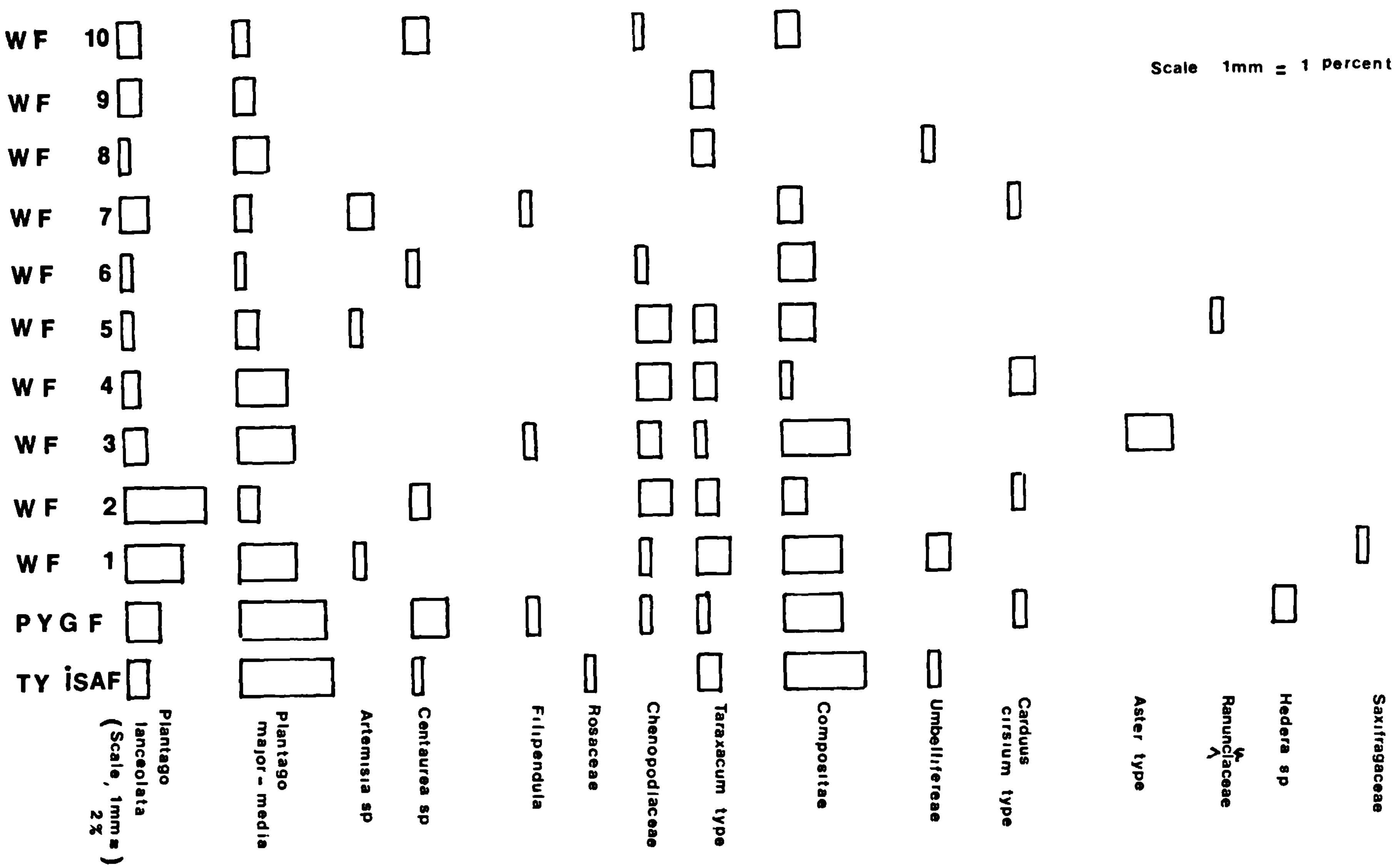


SCALE ' 1mm = 1 PERCENT

FIG, 3 2, SURFACE POLLEN FROM THE BLACK MOUNTAINS EXPRESSED AS A PERCENTAGE OF TOTAL ARBOREAL POLLEN



FIG, 33, SURFACE POLLEN FROM THE BLACK MOUNTAINS, PERCENT OF TOTAL ARBOREAL POLLEN



3.4 *Fraxinus* also appears to have an affinity for the end of the transect line . *Ulmus* is another genus having a marked affinity for the north - eastern end of the transect (sites Waun Fach 5 to 10 inclusive)

The general trend of higher T.A.P. percentages occuring at the north - east end of the transect suggests pollen - laden winds from an easterly or a south - easterly direction . The area , east of the Waun Fach summit is the Grwyne Fawr valley , a narrow isolated valley in the heart of the Black Mountains , stretching north north-east to south south-west .

In recent years , this valley has been transformed by the planting and establishment of the Mynydd Ddu forest . The composition of the forest is mainly coniferous , with *Picea sp.* representing nearly 50 % of the trees planted (see table 3.1) . The plantations extend up to 700 metres in elevation and are only 1.5 Km away from the Waun Fach sampling sites .

In view of the abundance of coniferous pollen , principally *Picea* , on the sample sites Waun Fach 4 to 10 inclusive , it seems reasonable to believe that the coniferous pollen on the north-eastern Waun Fach sample sites came from this extensive forest (15 square kilometres , see table 3 1

When the surface pollen results on the south-western end of the Waun Fach sample transect are examined , it will be seen that the T.A.P. percentages for ruderals such as *Plantago lanceolata* , Compositae and *Plantago major-media* are higher than at the north-eastern end . *Tilia* also is more prominent to the south-west of the transect (sites W.F.S. 1 and W.F. 2) .

This suggests that there are western or north-western pollen - laden winds which have deposited pollen mainly at the south-western end of the transect . These winds arrive mainly from the Wye lowlands where fairly extensive clearances have taken place since this is the main agricultural

3.4

area bordering the Black Mountains .

Thus it appears from the evidence of the ten Waun Fach pollen samples , that winds from two different geographical areas deposit pollen from somewhat different floras on adjacent sections of the Waun Fach summit . One wind is westerly and the other easterly .

The same phenomenon was apparent , over a vast span of time , with fossil pollen (see section 6.110, Fig 6.110). The " pollen shed " dividing line is a sharply defined demarkation . There is however , some spillage from both winds on both ends of the transect line .

W.F.S. 1 **SURFACE POLLEN - WAUN FACH SOUTH ;**

RESULTS AND RELATED LAND USE

3.5 It will be seen from Figures 3.1 , that the T.A.P. percentages for coniferous pollen (Picea , Abies and Pinus) are low on the Waun Fach South site . The small quantity of pollen which is present probably comes from the Wye lowlands . There are small coniferous plantations to the west some seven and ten kilometres away . It is also possible that some coniferous pollen may have arrived as spillage from the Grwyne Fawr valley .

Plantago lanceolata has 20 % T.A.P. compared to 10 % T.A.P. for Plantago major - media , and 2 % for cereal pollen . This trend of a higher proportion of pastoral to arable agriculture is the same as present land data suggests in the Wye lowlands (see Figure 3.3) . The probable area from which the Waun Fach South site receives pollen is shown in Figure 6.110 . This area is in the shape of a wedge radiating out from the pollen sample site .

Figure 3.1 shows Betula at 27 % of T.A.P. This genus is to be found in open woodlands , four kilometres away and due west of the pollen sample site . There are several , small scattered woodlands situated on gently sloping ground at an altitude of 380 metres . Quercus , which has a T.A.P. figure of 29 % is present in the hedgerows and in the same scattered woodlands as Betula .

Corylus , which is located in the same areas as Quercus , records the highest T.A.P. percentages on Waun Fach South , higher than on all the other Waun Fach surface sites . It is probable that there are more Corylus close to the Waun Fach South sample sites , than to other sample sites .

Tilia with 5 % T.A.P. is common in the wooded areas in the foothills some 4 to 4.5 kilometres west of the sample site .

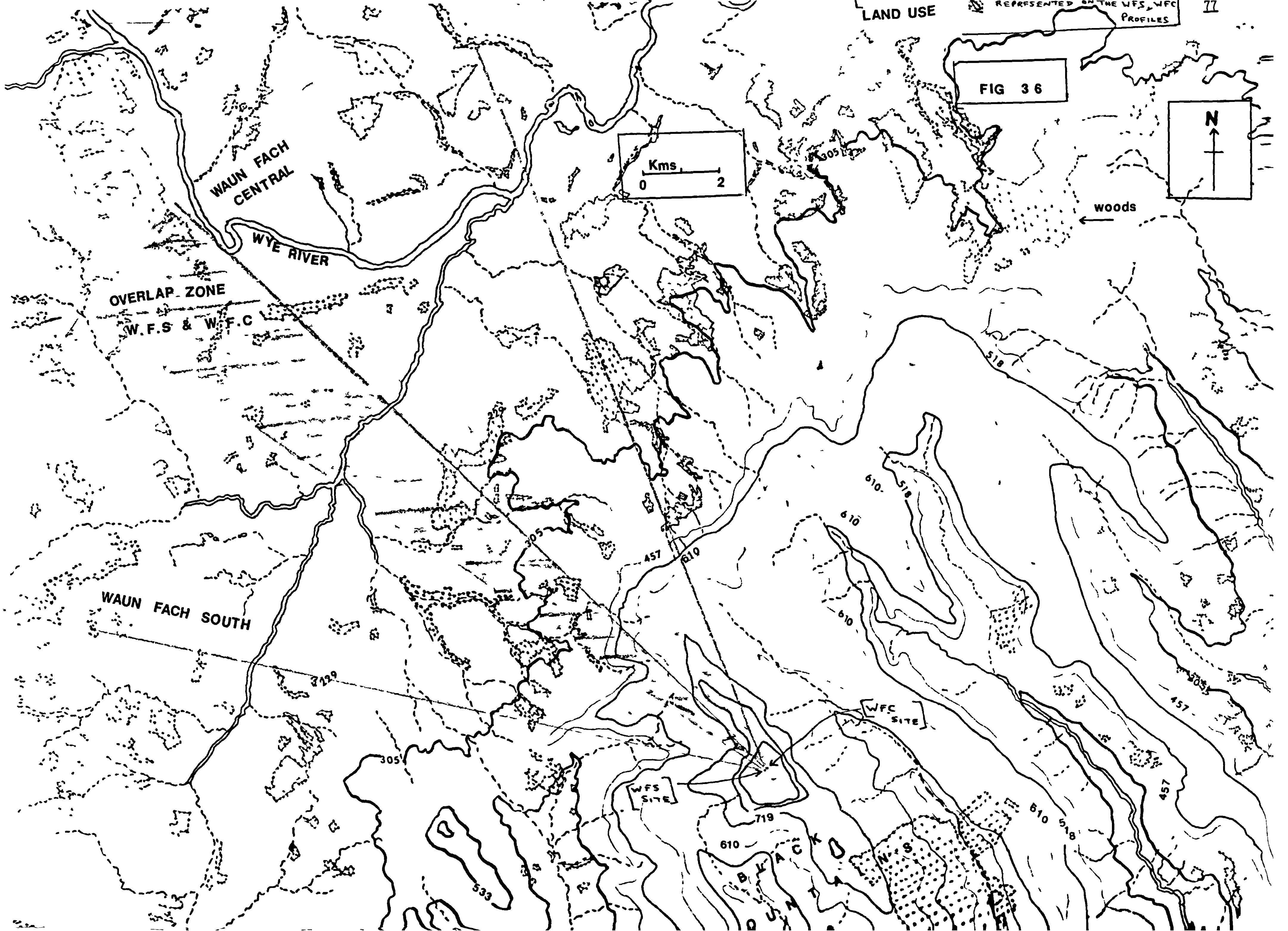
The 2 % T.A.P. figure for Ulmus (Figure 3.1) , is lower than the 5 % for Tilia and agress well with the land use survey in the area (Figure , 3.6) . Ulmus is located 5 to 6 kilometres west of the Waun Fach South site , in small woodland areas .

Alnus with 28 % T.A.P. (Figure 3.1) is to be found along stream borders , 4 kilometres away from the sample site . This genus is becoming more prolific at the confluence of three large streams , just south of Talgarth .

LAND USE

[PRESENT WOODED AREAS AND POSSIBLE AREAS REPRESENTED ON THE WFS, WFC PROFILES]

FIG 36



W.F.C. 3 SURFACE POLLEN - WAUN FACH CENTRAL

RESULTS AND RELATED LAND USE

3.6 The results of the surface pollen counts at the Waun Fach Central site are given in tables 3.1 , 3.2 and 3.3 . This site is probably receiving the bulk of it's pollen from the north-west , primarily from a fan-shaped area , out into the Wye lowlands . This area was defined as a result of fossil pollen data (see section 6.110) .

Within the fan-shaped area,(see Fig. 6.110) . the following genera of trees are located at distances given , these distances refer to the nearest trees of each genus to the sampling site .(DISTANCES LISTED BELOW)

Picea (4 % T.A.P.) , Pinus (3 % T.A.P.) , and Abies (2 % T.A.P.)

A proportion of the pollen of these genera may have come from the GRWYne Fawr valley , by a spillage over the pollen shed boundary , the boundry is situated between Waun Fach Central 3 and Waun Fach North 5 . There are also some coniferous plantations about six kilometres north-west of the W.F.C. 3 , sample site at an elevation of 320 to 390 metres and this is a likely area of origin .

Betula (33 % T.A.P.) , and Quercus (25 %) are present in small woodlands about 4 to 4.5 kilometres north-west from the sample site at an altitude of 340 metres . Corylus is also to be found with Betula and Quercus on the gentle slopes . Both Betula and Quercus are present in hedgerows in the same general area . All these genera are also common at lower altitudes .

Alnus with 27 % T.A.P. is common along stream banks and small tributarys of the Wye river , at a distance of 6 kilometres north-west of the sample site . The genus becomes more common as more streams converge on the Wye river.

Ulmus with 2 % T.A.P. is to be found as occasional individual trees , mostly below 300 metres altitude . The nearest trees to the sample site are

4.5 kilometres away from the site .

Tilia with only 1 % T.A.P. recorded on the sample site is actually more common than Ulmus . Tilia is to be found in small wooded areas and in hedgerows situated about 4.5 kilometres from the sample site .

Fraxinus is quite an uncommon genus in the Wye lowlands ; the 2 % T.A.P. recorded figure appears to be higher than expected . Fraxinus occurs as isolated trees , generally in open areas about 6 kilometres from the sample site .

In general , the pollen recorded on the Waun Fach Central site , probably represents a fan - shaped area extending in a north - west direction into the Wye lowlands . This area overlaps , and is similar to the probable area for the Waun Fach South site (see Figure 6.110) .

The surface pollen records , from the Waun Fach Central site , agree fairly well with the present land use in the area , in which about one third of the agriculture is arable .

W.F.N. 5 **SURFACE POLLEN - WAUN FACH NORTH**

RESULTS AND RELATED LAND USE

3.7 The surface pollen , recorded at the Waun Fach North site (W.F.N. 5) , contains a relatively high proportion of coniferous pollen . Picea registers 8 % T.A.P. ; Abies 5 % and Pinus 3 % . This coniferous pollen probably originates from the Mynydd Ddu forest which lies to the south east of the site .

Quercus with 27 % T.A.P. is to be found growing along the narrow roadway through the forest . Quercus is also found in narrow woodland strips which hug the 190 to 230 m , contour , some 9 km to the south east in the Grwyne Fawr valley . There are also oaks in the woods 7 km down the valley .

Corylus with 70 % T.A.P. , is also present in the forest and along the roadway as an understory shrub . This genus is also a hedgerow component in the more open areas of the Grwyne Fawr valley some 9 and 10 km down valley from the sample site .

There are a few fields of barley at the mouth of the valley in the open areas at a distance of 9 , 10 and 11 km The low cereal count of 2 % T.A.P. is probable due to the great distance of the nearest cereal crops.

Fraxinus , which registers only 1 % T.A.P. , can be found in the more open areas in the Mynydd Ddu forest . Two trees were seen high up on the eastern slopes of the Pen y Gader - Fawr mountain at elevations of 550 to 600 m only 3 kms. from the Waun Fach North site .

It seems doubtful however , that pollen from these particular , surrounded specimens , could reach the sample site . Other specimens of Fraxinus are present along the main Grwyne Fawr road , 6 and 7 km from the site .

Tilia , with 1 % T.A.P. is less proment in the narrow Grwyne Fawr valley than in the Rhian goll valley . Trees are to be found towards the mouth of the Grwyne Fawr , about 8 and 9 kilometres from the Waun Fach north sample site .

Ulmus , with 5 % T.A.P. , is found with *Quercus* , predominantly in the lower end of the valley . Areas in the Mynydd Ddu forest are constantly undergoing clearing , thinning and replanting as part of the forestry program .

The relative profusion of ruderals such as Chenopodiaceae , *Taraxacum* type and Compositeae probably originate in the Mynydd Ddu forest from the cleared areas . There are , of course , the other areas of clearance towards the mouth of the valley .

SURFACE POLLEN - PEN Y GADER - FAWR

RESULTS AND RELATED LAND USE

3.8 In order to appreciate the surface pollen results as shown in Figures 3.1 , 3.2 and 3.3 , it is necessary to re-consider the location of the pollen sampling site . This site is situated near the summit of the western watershed of Pen y Gader - Fawr (see Figures, 3.5 and 3.7) .

The site overlooks the Llanbedr valley , which lies to the west and which runs in south east direction for a distance of 9 + km. It is likely that pollen - laden winds channel up this valley and deposit pollen on the sample site . Winds blowing up the valley have been noted on several field trips to the area .

Fossil pollen records (chapter 6 , section 6.110) . provide the most convincing evidence that this valley is the principal area represented on the Pen y Gader - Fawr .

Surface pollen data shows a substantially greater proportion of Plantago - lanceolata to Plantago major-media .This suggests a predominance of pastoral rather than arable agriculture (Fig. 3.3). The present land use in the Llanbedr valley confirms this trend for agriculture is mainly pastoral. Because of the limited arable agricultural potential in the valley, the clearances most probably occur in the flatter, most open areas towards the mouth of the valley some 8 to 9 km away) . Pastoral clearances could be located as near as 4 to 5 km away on the valley floor to the south - east .

Picea and Pinus are both recorded in the surface pollen sample . Picea with 4 % T.A.P. and Pinus with 1 % T.A.P. The pollen for both genera are most probably from the small , relatively new plantations in the Llanbedr valley . One plantation is 1.5 to 2.5 km south of Pen y Gader-Fawr at elevations of 380 to 550 m Other stands of trees are also in the Llanbedr

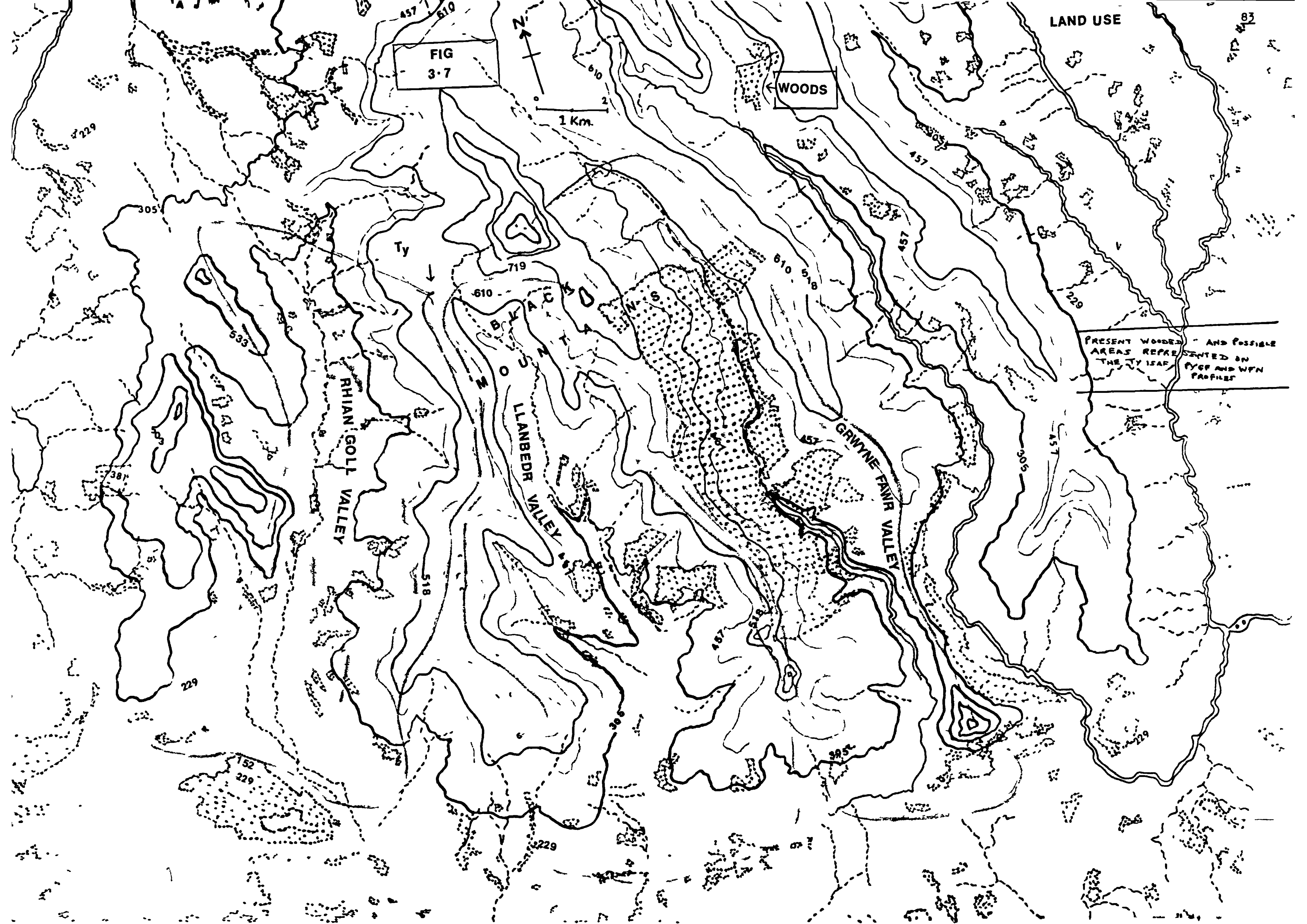


FIG 3·7
N
0 1 Km. 2
WOODS
PRESENT WOODED AND POSSIBLE AREAS REPRESENTED ON THE TY ISAF PYGF AND WFN PROFILES
BLACK MOUNTAINS
GRWYNE FAWR VALLEY
LLANBEDR VALLEY
RHIAN GOLL VALLEY
Ty
719
610
518
457
305
229
533
381
152

valley 4 and 6 km south east from the site .

Alnus is common in the lower reaches of the valley along stream banks. The nearest trees are less than 3 km away from the sample site . The genus becomes very common further down the valley . where several streams feed into the valley .

Ulmus with 4 % T.A.P. (Fig. 3.1) is often found in small *Quercus* woods situated 6 km down stream to the south-east . The genus becomes more common 8 to 9 km distance from the site at the mouth of the valley . *Betula* is found in small wooded areas and in hedgerows in the Llanbedr valley . The closest trees are found near the stream bed of the valley , 4.5 km from this sampling site at an elevation of 320 metres .

Quercus is also found with *Betula* 4.5 km . from the site and is also found in profusion 6 km to the south-east where the valley widens slightly . *Tilia* , a less prominent genus than *Quercus* is also found 4.5 km away from the sample site . It is also found in hedgerows further down the valley . In fact most arboreal genera are found in greater numbers when the valley widens at it's mouth 8 to 9 km to the south-east .

Corylus is associated with *Quercus* woodlands and is occasionally as marginal scrub in the valley . It becomes most prominent at the mouth of the Llanbedr valley , 8 to 9 km , from the sample site . There is also some *Corylus* higher up the valley, only 4 to 5 km , from the site (see Fig. 3.7) .

PEN Y GADER - FAWR , CONCLUSIONS

Surface pollen data indicate greater pastoral than arable activity . This is also the actual trend of present land use in the valley which has limited arable potential . This is because the largest proportion of the valley consists of steep slopes , which are only suitable for pastoral agriculture .

The low incidence of coniferous pollen corresponds to the relatively small proportion of plantations in the valley . The figures of 4 % T.A.P. for both *Ulmus* and *Tilia* are as expected. *Tilia* is a common hedgerow component .

SURFACE POLLEN , TY ISAF

RESULTS AND RELATED LAND USE

3.9 Surface pollen data from the Ty isaf site record high levels of clearance activity . The Plantago lanceolata and Compositae T.A.P. percentages are higher than on any of the other surface pollen sites (see Fig. 3.3) .

The Ty isaf site is situated on a high narrow ridge dividing the Rhian goll and the Llanbedr valleys . The Rhian goll valley lies to the west of the sample site and extends 2 km north and 7 km south of the site . The prevailing winds are westerly although wind is also channelled along the length of the Rhian goll valley . Because of this , it is reasonable to expect that a significant proportion of pollen arriving on the Ty isaf site , comes from the Rhian goll valley . Pollen data in chapters 6 and 7 support this view.

The Ty isaf surface pollen data (Fig. 3.1) , show low T.A.P. percentages for both Picea and Pinus . The significant presence of Betula together with high Plantago lanceolata T.A.P. percentages support considerable clearance in the Rhian goll valley . Of these clearances only a small proportion are for arable purposes .

The particularly high Ericaceae figure of 970 % of T.A.P. reflects the abundance of these plants on the lower slopes to the west below the sample site .

At present , Betula trees are located in lowland small wooded areas or in hedgerows in the Rhian goll valley . The nearest trees are west , just over 1 km. away in hedgerows at an elevation of about 200 metres. The trees are a common site in most of the lowland areas of the valley . Two kilometres north west of the Ty isaf is a small wooded area , which has significant numbers of this genus on its periphery .

The closest northern site is on the northern slopes of the Black Mountains , 5.5 kms. away at an elevation of about 350 m The closest eastern site to Ty isaf is in the lower Llanbedr valley 5 to 6 km away .

Quercus pollen is well represented on the Ty isaf site , with nearly 30 % T.A.P. This genus is common in the Rhian goll valley . Quercus can be found also in hedgerows but more often occurs in small wooded areas in fields . The closest oak tree in this valley is to be found to the west and south-west , at a distance of 1 kilometre .

Subs tantial numbers of this genus are to be seen growing in a wood near Castel Dinas , 2 km to the north - west in the northern end of the valley .

Tilia is a well - established genus in the low areas surrounding the Black Mountains , where it is found as a woodland component or as solitary trees in hedgerows .

In the Rhian goll valley there are numerous individual trees in the hedgerows and in small woods . These lie to the west and south of the Ty isaf site at elevations of 300 to 350 metres .

Alnus trees are located along the borders of streams and in damp woodlands in the Rhian goll valley . Alnus is to be found at higher elevations than most other tree genera . Thus in the Rhian goll valley Alnus is found bordering streams up to 450 metres in elevation . This genus also occurs on the northern slopes of the Black Mountains up to 420 to 430 metres in elevation (plate 6.2).

Fagus is not represented on the Ty isaf sample site and is generally rarely found on the Black Mountain s sites . Occasional solitary trees can be found in residential areas in the southern part of the Rhian goll valley some few kilometres away . There are also a few individual trees in hedgerows , two kilometres to the west of the Ty isaf sampling site .

Corylus is associated with Quercus and its distribution in the Rhian goll valley is similar to Quercus . Fraxinus is uncommon in the Rhian goll valley . Some trees have been observed to the south , about 3 or 4 km from the sample site .

TY ISAF , CONCLUSIONS

The Ty isaf surface sample does show appreciable clerances , the great majority of which are pastoral . This finding compares favourably with the present land use situation .

The prominent presence of Tilia both in the surface sample and in present - day vegetation in Rhian goll valley provides a further demonstration of the agreement between present land use and the surface pollen record . In addition the relatively low T.A.P. percentages for both Picea and Pinus agree well with the present land use picture .

LAND USE IN THE BLACK MOUNTAINS REGION – OBJECTIVES

3.10 It is necessary to obtain a general picture of existing Land Use on the mountains and in the valleys of the whole of the Black Mountains region in order to relate the various land uses to the pollen patterns found on the blanket peat surfaces. In other words, to determine how closely, existing pollen rain reflects the land uses and the activities of man and animals at the present time. The results of such a study will help us to understand how fossil pollen assemblages reflect land uses and activities at various times in the past (see Figures , 3.6 & 3.7) .

THE PRESENT LAND USE PICTURE

3.11 In general the overall picture of Land Use is one of extensive pastures and some cereal production in the low-lying areas with upland areas used primarily for sheep grazing. In addition certain upland and valley areas have been used for afforestation and as reservoir catchment areas. Parts of the region have been set aside as National Parks which provide recreational facilities .

The forest area of Mynydd Ddu is of particular interest because of its proximity to Waun Fach where the surface pollen assemblage is influenced by the proximity of this forest (see Figure 3.6) .

LAND USE - THE MYNYDD DDU FOREST

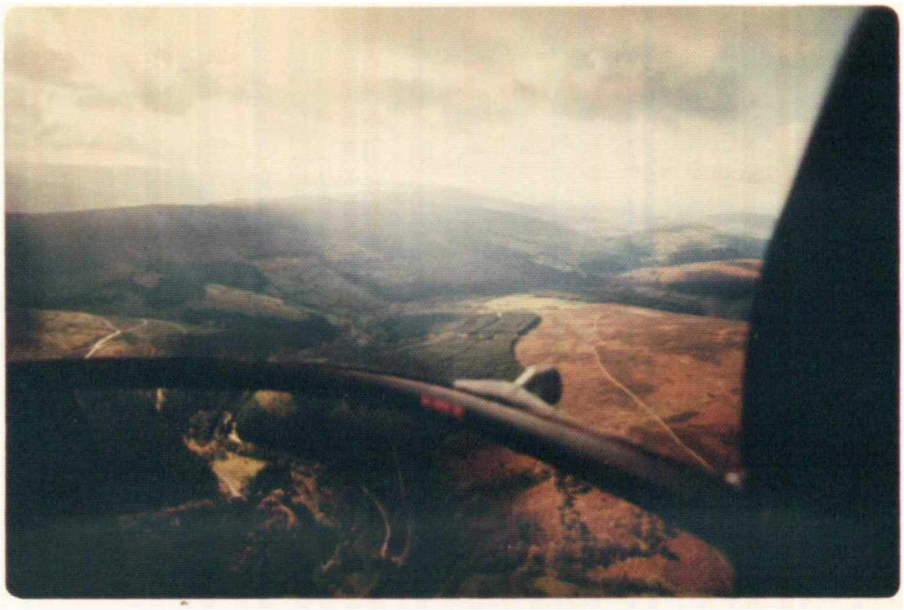
3.12 The afforestation of the Mynydd Ddu area was commenced in 1934 when allocation was given for the planting of 2045 hectares of trees . Up to the present , 1500 hectares have been planted (see Figure 3.6 , and table 3.1 , and Figure 3.7 .

The forest is located in the valley of the Grwyne Fawr which flows through the heart of the Black Mountains and joins the Usk river to the South .

The plantation lies mainly on the western slopes of the Grwyne Fawr valley and extends upwards to an elevation of 700 metres , and along the valley for a distance of over 7000 metres to the eastern slopes of Pen y Gader - Fawr .

The forest overlies Old Red Sandstones with its characteristic red clayey soils at the lower elevations and on peat at the higher elevations . In some areas broken sandstone Scree is mixed with the soil , giving it a stoney texture . The density of planting averages 3160 trees per hectare , (see Table 3.1 and Plate 3.4) , (Mynydd Ddu forestry - commission , Black Mountains , South Wales) .

Plate 3.4



Afforestation in the Black Mountains looking south . Coniferous pollen from the Mynydd Ddu forest is blown up the Grwyne Fawr valley and on to the Waun Fach , north side .

THE COMPOSITION OF THE FOREST

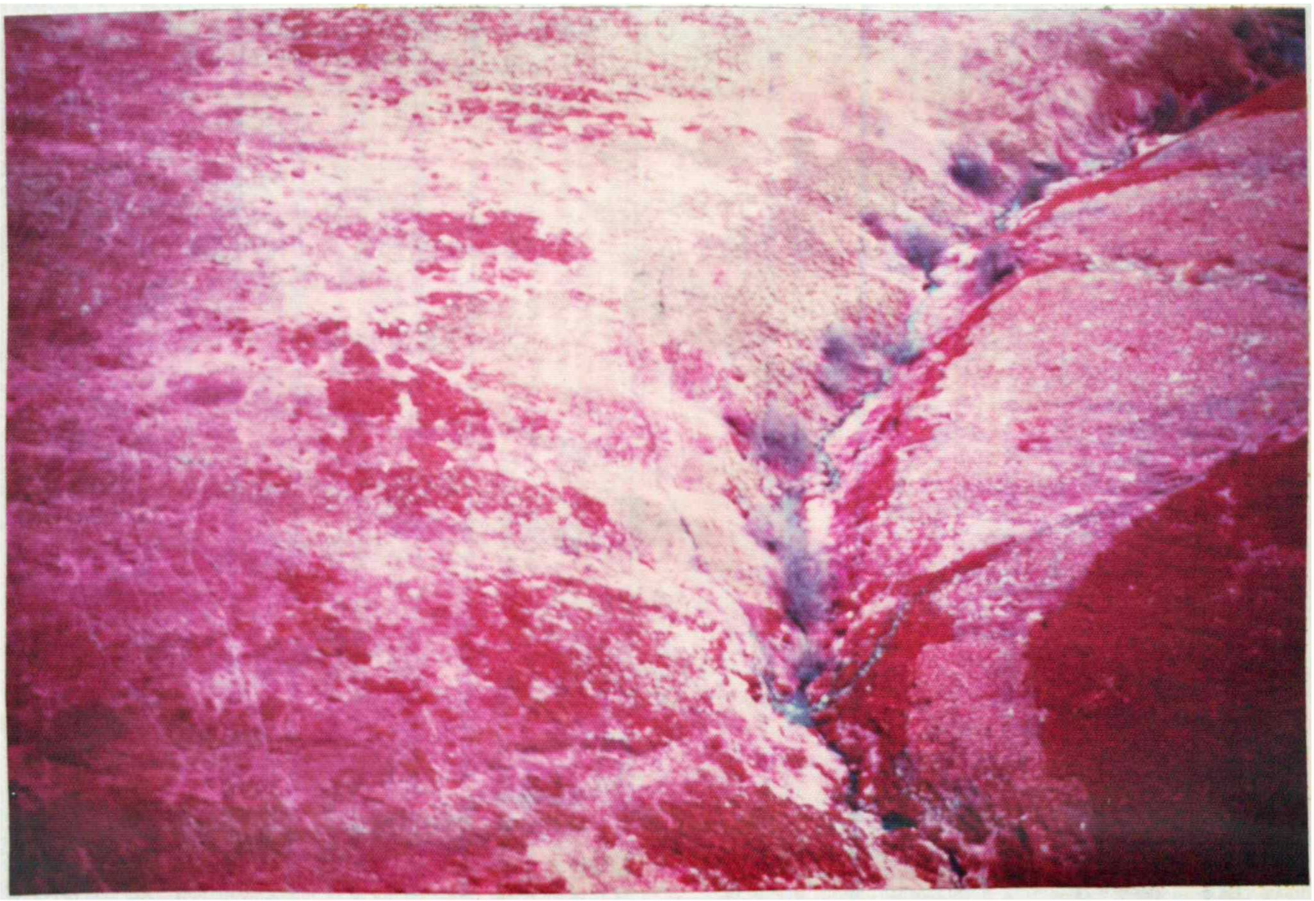
Table 3.1 gives details of the composition of the Mynydd Ddu forest from which it will be seen that nearly half the trees are *Picea sitchensis* while a further third are *Larix* sp. Thus the forest is approximately three quarters *Picea* and *Larix*, and 92 % is coniferous.

Table 3.1 : Composition of the Mynydd Ddu Forest in the Grwyne Fawr valley, Black Mountains.

Species	Percentage of total composition of forest
1 - *Picea* sp.	47 %
2 - *Larix* sp.	27 %
3 - *Pinus* sp.	6 %
4 - *Pseudotsuga menzesii*.	6 %
5 - *Abies* sp., *Tsuga* sp., *Thuja* sp.	6 %
6 - *Quercus* sp.	3 %
7 - *Fagus* sp.	3 %
8 - *Fraxinus* sp., *Populus* sp., *Plantanus* sp., *Castanea* sp.	2 %

Note : Data supplied by the Forestry Commission in the Mynydd Ddu office, Black Mountains, South Wales.

Plate 3.0



This is one of the three infra-red photographs taken in rapid succession while flying over the northern bluff of the Black Mountains. This photo is showing streams as blue in shallow gulley, with Vaccinium sp. as a mauve, bushy plant. In the foreground on the bottom right of photograph is Calluna (dark red) , surrounded by grasses (lighter red) .*NOTE GENERA NOT CONFIRMED BY GROUND INSPECTION.

LAND USE - SHEEP GRAZING ON THE PLATEAUX AND UPLAND SLOPES OF THE BLACK MOUNTAINS

3.13 Sheep have been grazing on the Black Mountains for many centuries and very probably grazed in Neolithic times. Sheep grazing on the plateaux and upland slopes of the Black Mountains , covers an area of over 192,000 hectares. In the winter months many sheep are brought down from the hills to feed in the valleys and lowland areas around the Black Mountains.

About 300 farmers from 3 counties,Breconshire, Monmouthshire and Herefordshire graze,their sheep on the Black Mountains. Around Hay on Wye, Talgarth, Crickhowell, Cwmdu, Tretower and Crucorney there are about 200 farms. The average farm is about 68 hectares with 300 to 400 sheep and 50 cattle. (Hay on Wye area), Stevens W. (1979, personal communication) .

In addition to sheep,there are Black Mountains ponies which graze the year round. Their numbers are diminishing however, since it is now uneconomic to graze ponies ; foals sell for £ 20 to £ 30 each , the same price as a lamb. The net result is that today there are only about 100-150 ponies on the Black Mountains whereas eight years ago there were 1,000 to 1,500 ponies grazing. Sheep are now almost exclusively for meat whereas in the recent past wool was more important , Stevens , W . , (1979), (personal communication) ,, (see Plates 3.0 & 3.2) .

LAND USE - RECREATION IN THE BLACK MOUNTAINS REGION

3.14 The Black Mountains comprise the eastern portion of the Brecon Beacons National Park , which provides recreational facilities for the large population in the industrial parts of South Wales .

The numerous trails and picnic areas are used by large numbers of tourists each year . This activity has its effect on the environment and is a disturbing factor for wild life and sheep .

LAND USE - WATER CATCHMENT AND THE GRWYNE FAWR RESERVOIR

3.15 In the heart of the Black Mountains , the upper reaches of the Grwyne Fawr valley , have been dammed to create the Grwyne Fawr reservoir . This reservoir , supplies water to the industrial Midlands of Britain .

The water catchment area for the upper Grwyne Fawr valley is greatest on the eastern slopes of Waun Fach (810 metres) , where precipitation is the highest in the Black Mountains (see Table 1.1) .

LAND USE IN THE VALLEYS AND LOWLANDS

BORDERING THE BLACK MOUNTAINS

3.16. The lowlands and valleys bordering the Black Mountains are in a large crescent stretching from Hay on Wye, Talgarth and Llangorse lake to Crickhowell and Abergavenny.. This area has supported both man and livestock since 3020 ± 80 years b.p. in Neolithic times , Savory (1980). In general, Randor and Randor-cross Welsh sheep predominate and Hereford cattle are the main breed in this area, Stevens (1979 , personal communication) .

In Breconshire* as a whole the ratio of cattle to sheep is given in Table 3.2 , which is reproduced from the Breconshire Official County Guide. It will be seen from this table that the total numbers of grazing animals has increased through the years and that since 1960 the proportion of sheep to cattle is about 11 to 1 .

As might be expected , in the immediate vicinity of the Black Mountains, the proportion of sheep to cattle increases to a ratio of about 12:1 (14:1 Crucorney area , see Plate 3.1) .

In the area under discussion, the Land Use may be divided into three different categories or types as follows:

3.17 Type I - In the Talgarth , Bronllys and Glasbury areas , the average farm has an acreage of from 59 to 68 hectares of which : -

a) 48 to 52 hectares are for grazing cattle , with cattle feeding mainly on the rich alluvial soils of the river Wye and with the sheep confined to poorer soils. Here the ratio of sheep to cattle can vary from 3:1 to 10:1 (see Table 3.2) .

* Breconshire name derivation , see appendix , 1.1b .

TABLE 3.2

* RATIOS OF CATTLE TO SHEEP IN BRECONSHIRE

FOR THE YEARS 1939, 1960 AND 1971

YEAR	1939	1960	1971
TOTAL CATTLE INCLUDING COWS CALVES AND OTHER CATTLE	.40,391	61,419	71,461
TOTAL SHEEP INCLUDING BREEDING EWES, SHEARLINGS, LAMBS, ETC.	555,400	678,600	796,611

* Reproduced from the Breconshire Official County Guide

Plate 3.1

Cattle grazing up to the tree line (Crataegus sp.) , in the Rhian goll valley , S.O. 193292 . Also showing Pteridium growing on far hillsides , and with Alnus growing along the meandering stream - bank .

b) 11 to 17 hectares are sown with cereals in the proportion 2/3 Hordeum sp. and 1/3 Triticum sp. Avena sp. however, are increasingly sown on hill slopes, Morgan A. (1979, personal communication).

c) 4 to 5 hectares are devoted to root crops in the following order of importance : -
Brassica napus (Swede) , Beta vulgaris (Mangold wurzel) , Brassica oleifera Moench (Rape), and Solanum tuberosum (seed potato), Morgan A. (1979, personal communication) .

3.18 Type II , Rhian goll valley :

In the area embracing Crickhowell , Cwmdu and Tretower , the farms are smaller and consist mainly of grazing land. Although , some root crops are grown , there are few , or no cereals . The sheep-cattle ratio varies from 10 : 1 to 8 : 1 , as might be expected on the poorer soils . There are some ponies in the area of Rhian goll , Jones . D. (1979 , personal communication) , (see Table 3.3 and Plate 3.3) .

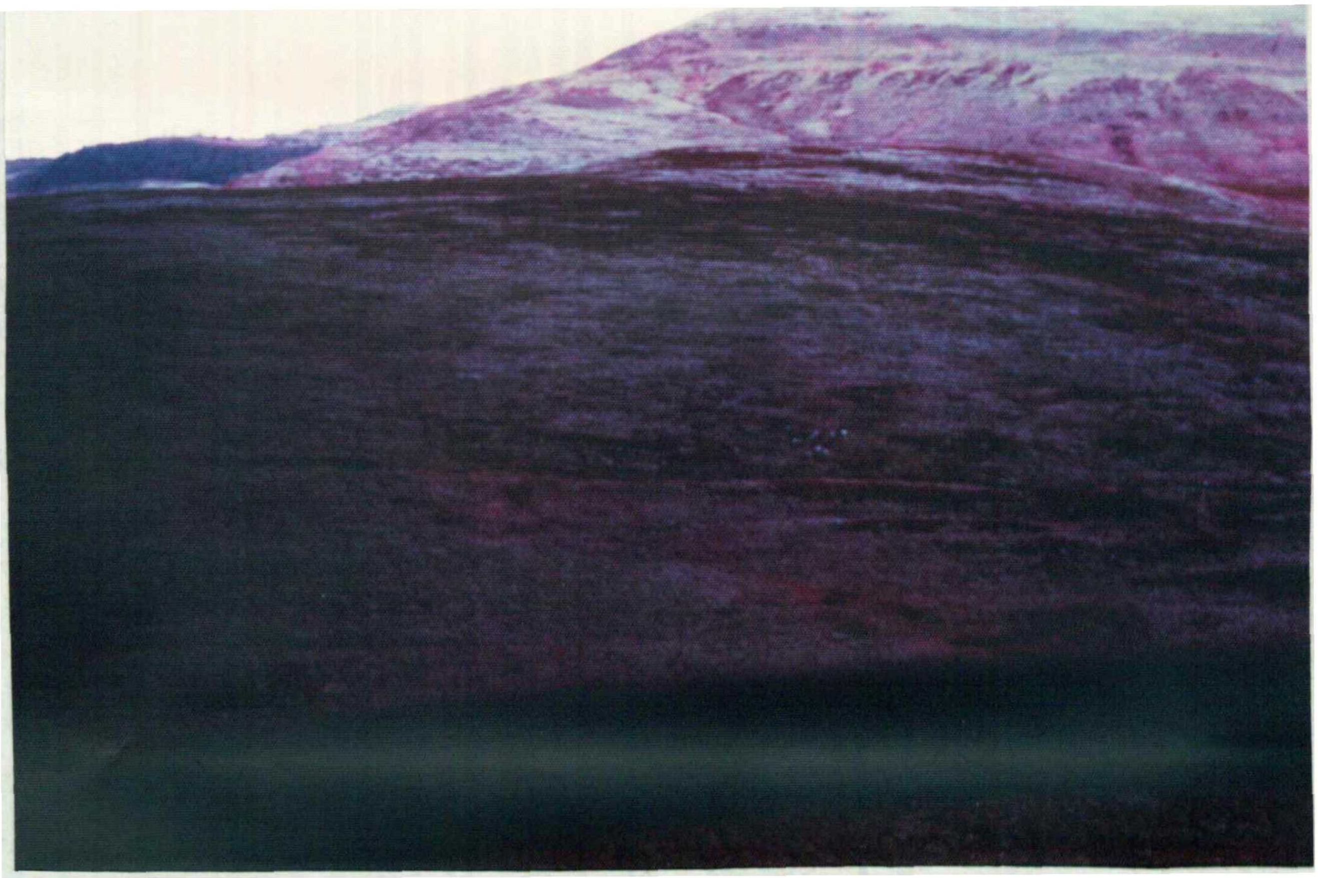
3.19 Type III , Grwyne Fawr and Llanbedr valleys :

In this category are included farms in the heart of the Black Mountains including the Grwyne Fawr and the Llanbedr valleys . Here the sheep-cattle ratio increases from 12 : 1 to 14 : 1 , because of the preponderance of sheep on the Black Mountains plateaux and slopes .

There is very little cereal production except on a Hordeum sp.(barley) field or two (2 to 3 hectares) . The root crops are mainly

Brassica napus (swede) and *Brassica rapa* (turnip) , Jones , D. (1977) . (Personal communication) , (see Table 3.4) .

Plate 3.2



Infra-red aerial photograph on the flat topped northern Black Mountains, which overlook the Wye lowlands to the north. The upper slopes of the northern plateau are seen in the background .

Plate 3.3

Aerial photograph of vegetation of Pen Cerrig - calch , SO . 217224 . And the entrance of the Rhian goll valley running roughly south to north (background) .

The following tables 3.3 and 3.4 are present land use estimates of the probable areas which are represented on the sample pollen sites . The areas were measured from ordinance survey maps (1 : 25,000) aerial. photographs , field data and discussion with farmers in each main area . Table 3.4 in particular gives the land use in valley areas .

TABLE 3.3

PRESENT LAND USE , IN THE BLACK MOUNTAINS REGION , OF THE SURROUNDING AREAS , WHICH CONTRIBUTE POLLEN RECORDS ON THE SAMPLING SITE

(a) From mainly lowland areas .

Waun Fach South

The total area (fan-shaped) , which extends westwards for a distance of 12.5 kilometres from the site is 29 square kilometres , which is sub - divided as follows :

(i)	upland grazing	2.0	square	kilometres	or	6.9 %
(ii)	lowland grazing	15.5	"	"	"	53.4 %
(iii)	crops	8.0	"	"	"	27.6 %
(iv)	woodlands	3.5	"	"	"	12.1 %

See Figure 3.6 .

Waun Fach South - Waun Fach Central , overlap area

The total area (fan - shaped) , which extends north - westwards for a distance of 12.5 kilometres from the site is 16.5 square kilometres , which is sub - divided as follows :

(i)	upland grazing	1.5	square	kilometres	or	9.1 %
(ii)	lowland grazing	8.5	"	"	"	51.5 %
(iii)	crops	4.0	"	"	"	24.2 %
(iv)	woodlands	2.5	"	"	"	15.2 %

See Figure 3.6

Waun Fach Central

The total area (fan-shaped) which extends north north - west distance of 12.5 kilometres from the site is 35 square kilometres , which is sub - divided as follows :

(i)	upland grazing	3.0	square	kilometres	or	8.6 %
(ii)	lowland grazing	19.5	"	"	"	55.7 %
(iii)	crops	9.5	"	"	"	27.1 %
(iv)	woodlands	3.0	"	"	"	8.6 %

See Figure 3.6

TABLE 3.4

PRESENT LAND USE , IN THE BLACK MOUNTAINS REGION , OF THE SURROUNDING AREAS , WHICH CONTRIBUTE POLLEN RECORDED ON THE SAMPLING SITE

(b) From mainly uplands and valley areas ;

Waun Fach North :

The total area , which extends south - eastwards over the Grwyne Fawr valley for a distance of 11 kilometres from the site is 28 square kilometres, which is sub - divided as follows :

(i)	upland grazing	8.25	square	kilometres	or	29.5 %
(ii)	valley bottom grazing	4.5	"	"	"	16.0 %
(iii)	crops	0.25	"	"	"	1.0 %
(iv)	forests	115.0	"	"	"	53.5 %

See Figure 3.7

Pen y Gader - Fawr :

The total area , which extends south - eastwards over the Llanbedr valley for a distance of 9 kilometres from the site is 23 square kilometres , which is sub - divided as follows

(i)	upland grazing	9.0	square	kilometres	or	39.0 %
(ii)	valley bottom grazing	11.0	"	"	"	48.0 %
(iii)	crops	0.5	"	"	"	2.0 %
(iv)	woodlands	2.5	"	"	"	11.0 %

See Figure 3.7

Ty isaf (on Pen Trumau) .

The total area , which extends southwards over the Rhian goll valley for a distance of 8 kilometres from the site is 27.5 square kilometres , which is sub - divided as follows :

Ty isaf (continued)

(i)	upland grazing	2.0	square	kilometres	or	7.0 %
(ii)	valley bottom grazing	20.0	"	"	"	72.5 %
(iii)	crops , or a maximum of	4.0	"	"	"	15.0 %
(iv)	woodlands	1.5	"	"	"	5.5 %

, See Figure 3.7

LAND USE

THE GENERAL PATTERN OF VEGETATION IN THE VICINITY OF THE POLLEN SAMPLING SITES ABOVE THE PRESENT TREE LINES

3.20
A survey was carried out on the Black Mountain's plateaux where the sampling sites are located, including the surrounding slope areas down to the tree line. For palynological purposes the plants identified were grouped generally as follows : -

1. Gramineae
2. Cyperaceae.
3. Ericaceae
4. *Pteridum* sp.
5. Juncaceae

See Fig. 3.8, after Coleman A.

A. WAUN FACH SITES

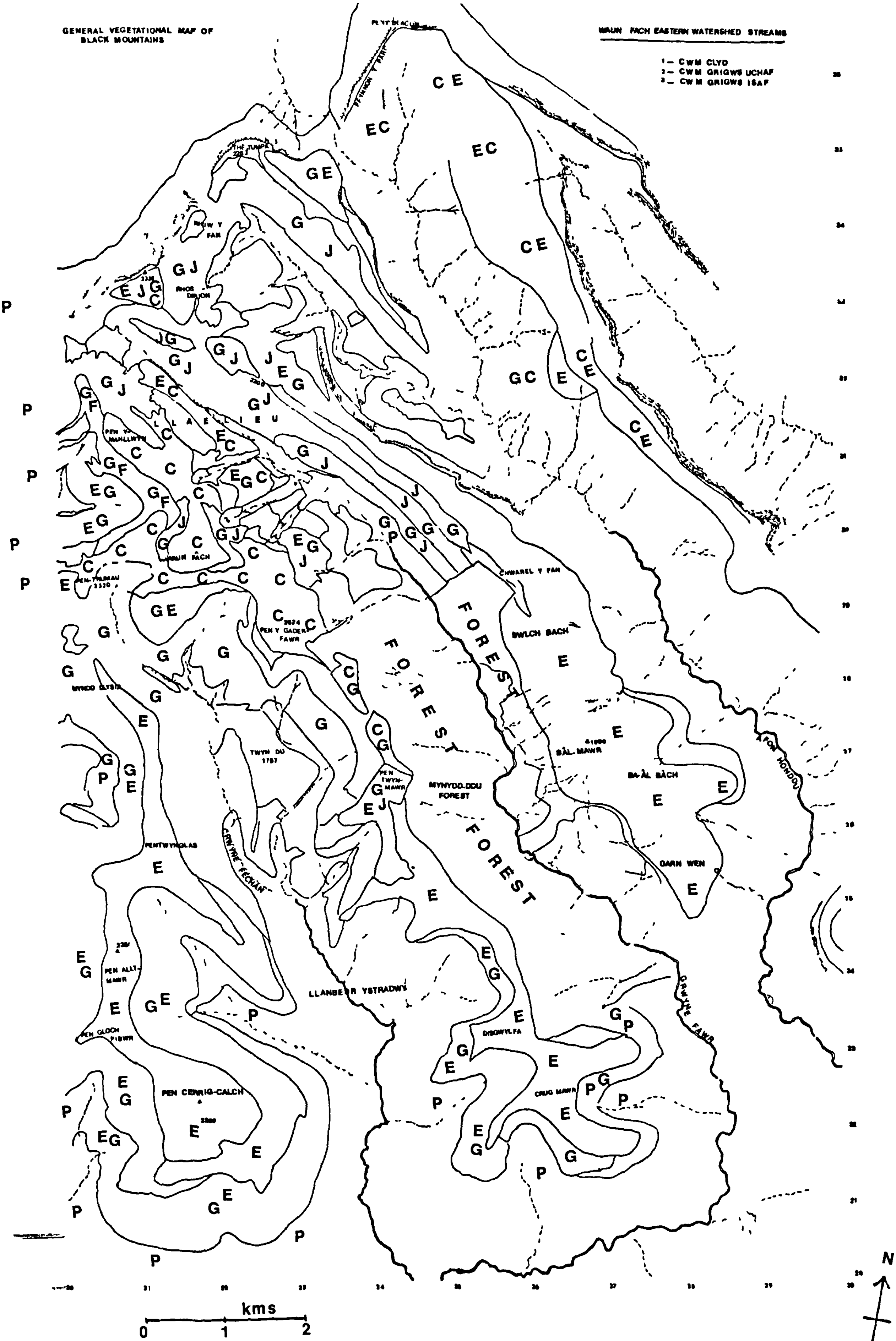
3.21
(i) Waun Fach Summit.

On the flat plateau on which are located all three sites, Waun Fach North, Central and South, the predominant plant species are : the common cotton grass, *Eriophorum angustifolium* and cotton grass, *Eriophorum vaginatum* (see Plate 4.1). Other plants, found in sheltered, eroded peat bog areas include : Ericaceae ; *Carex* sp. ; *Vaccinium* and the two cotton grasses *Eriophorum angustifolium* and *Eriophorum vaginatum*, and *Trichophorum*

3.22
B. PEN Y GADER-FAWR

(i) Pen y Gader-Fawr, site area.

In the immediate vicinity of the sampling site are to be found, *Eriophorum angustifolium*, some *Agrostis* with occasional *Vaccinium* in between in sheltered haggs.

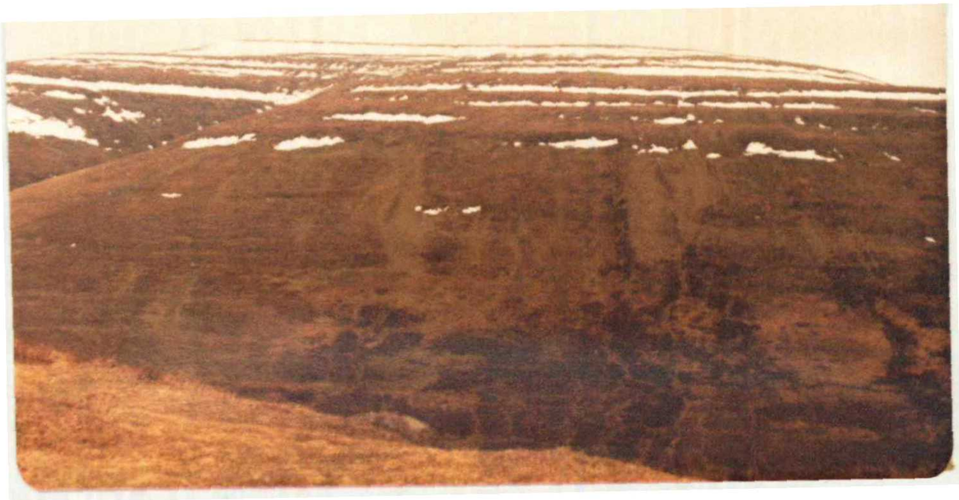


FIG, 3.8 GENERAL VEGETATION OF THE BLACK MOUNTAINS, UPLAND AREAS

E	Ericaceae	J	Juncaceae	G	Gramineae
C	Cyperaceae	P	Pteridium		

(After Coleman A)

Plate 3.5



The Waun Fach summit (810 metres) . Viewed from the south - west ,
SO . 215219 , in winter .

Plate 3.6

Aerial photograph showing Pteridium (brown) , and tree line of Hawthorn (Crataegus sp.) , on slopes of the Rhian goll valley .

Plate 3.7

Aerial photograph of Pen Cerrig-calch , showing limestone and sandstone outcrops above *Pteridium* .

C . TY ISAF SITE

(i) Immediate vacinity of the site .

3.23 The vegetation , in the immediate vicinity of Ty isaf site , consists of *Eriophorum angustifolium* , *Vaccinium sp.* , *Juncus squarrosus* and *Festuca* / *Agrostis* .

(see plates 3.6 , and 3.1) .

SURFACE POLLEN STUDIES , CONCLUSION

3.24

To sum up , the surface pollen studies ;

(1) Have given an indication of how representative surface pollen data is to its immediate and local surrounding (e.g. up to 6 to 12 kilometres distance from collection site) .

(2) Indicate, that at least two separate geographical areas are represented on the Waun Fach surface sample sites .

(3) Suggest that , number (2) , as above , may be explained using a " pollen shed " theory (see section 6.110) .

(4) Indicate that the " pollen shed " dividing line is not an impervious barrier, but that, there can be spillage on either side of the line from opposite pollen sources . This " pollen shed " demarcation is probably more evident when viewed over a long period of times as suggested by the fossil pollen records (see sections 6.5 to 6.9 inclusive) .

(5) Show that the larger proportions of Plantago lanceolata pollen to Plantago major-media pollen is not directly proportional to present land use . It does however show the same trend of more pastoral than arable agriculture . This is particularly useful in evaluating fossil pollen data .

(6) Suggests, that surface vegetation approximately 0 to 400 metres radius surrounding the pollen sites (on Waun Fach and Pen y Gader-Fawr), is poorly represented . This is particularly true of Cyperaceae .

(7) Indicate that , little or no pollen is deposited by wind from a northerly direction on the Waun Fach North site .

Comparisons between land use and present surface pollen records should be treated with caution . The distance from the site and the extent of woodlands is very important . For example , a large clearance 4 kilometres away , could be recorded on the surface sample site at the same magnitude as a small clearance (2 kilometres distance) , therefore , such comparisons should be regarded as a general guide only .

CHAPTER FOUR

THE SELECTION OF SAMPLING SITES FOR POLLEN ANALYSIS AND RADIO-CARBON DATING OF PEAT FROM THE BLACK MOUNTAINS

Peat cores or monoliths from five sites were collected from selected locations on the Black Mountains . Monoliths from three of these sites were prepared for radio - carbon dating .

THE FIVE SITES

4.1 Core and monolith samples of the blanket peat were taken from three locations on Waun Fach , from one location on Pen y Gader-Fawr and from one location on Pen Trumau (see Figure 4.1) . Each particular site was selected for the following special reasons

4.2 1 - The Ty isaf site on Pen Trumau (SO 204291) :

The site is named after the long barrow , Ty isaf in the valley below . The reasons for this choice of site were : -

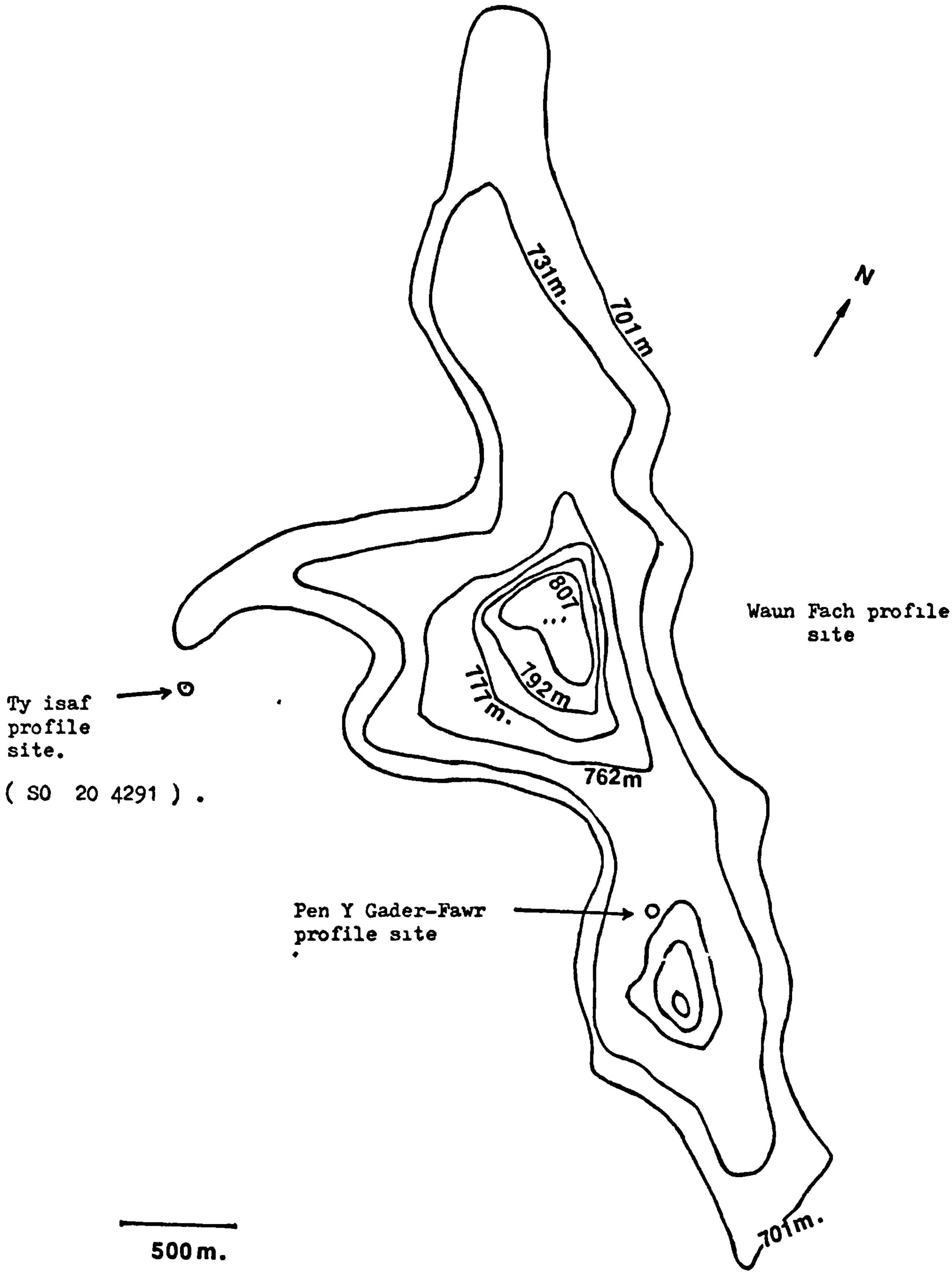
(i) The Ty isaf site overlooks the Rhian goll valley to the west . This valley contains numerous archaeological stuctures and artifacts . These include Neolithic long barrows ,,7.7.52 and 7.43 . Bronze age barrows ; 7.3 , 7.31 and 7.32 .

Also situated in this valley are Norman and medieval structures with Iron age hill forts and a Roman camp. It is hoped that the past human activity in the valley will be reflected in fossil pollen data from the Ty isaf site (see Figure 4.1) .

(ii) The deepest peat on the southern tip of Pen Trumau was found at this site (see Figure 2.3) , at an altitude of 648 metres .

(iii) This site lies west of the Waun Fach and Pen y Gader-Fawr sites and is closer to centres of human activity (see Figures 2.3 and 4.1) .

Figure 4.1 · Location of the Black Mountains pollen profiles .



4.3 2 - The Pen y Gader - Fawr site (SO 228288) .

This site is located on the western crest of Pen y Gader - Fawr mountain at an altitude of just under 760 metres , and is the most southerly of the Black Mountains sites .

Situated as it is on the southern point of the central massif , the sites occupies a significant position on the western watershed (see Figs. 6.110 & 4.1). The reason for the particular choice of the sites are as follows : -

(i) Since this site lies on the western watershed of Pen y Gader - Fawr , comparison with Waun Fach sites should be of considerable interest because of the varying distances from centres of human activity and areas of disturbances to the flora .

(ii) On this site are to be found the deepest and most southerly peats of the central massif,(i.e. Waun Fach , Pen y Gader-Fawr peaks) .

(iii) The sampling site is located a short distance away from an array of " finds " as follows : -

(a) Remains of Betula and Quercus wood were found at the base of the peat on the Gader Mountain (Pen y Gader-Fawr) at an altitude of over 770 metres at a distance of 150 metres south - east of the sample site , (Figure 4.1) .

(b) A Neolithic adze of Wil tshire chert was found on the rock floor of an erosion channel cut in peat in the same general location as (a) , by Blundell , G . E . , (1939) .

(c) A Bronze axe (see Figure 7.31 , was also found on the summit of Pen y Gader-Fawr .

(d) " Druid " stone circles and lines of stones (presently absent) had been constructed on the top of this mountain and along the adjoinning ridge towards Waun Fach summit , Theophilous Jones ,(1809) . The stones may have been erected much earlier , e.g. in Bronze age times.

(e) A Neolithic reworked axe head was found on the Pen y Gader - Fawr summit by Lewis , T. H. , (1963),(head forester of Mynydd Ddu).

(f) Finally about 60 Neolithic and / or Bronze age flint and chert fragments (imported) have been found on Pen y Gader - Fawr , on slopes of the eastern watershed of the Mynydd Ddu forest (collected by a forester of the Mynydd Ddu forest) .

3 - The three Waun Fach Sites .

4.4 The three sites selected on Waun Fach were all at altitudes just below 810 metres and were situated at 40 and 50 metres intervals along a line running from south-west to north-east . They are referred to as Waun Fach South sites ; Waun Fach North and Waun Fach Central (see Figure 4.2 , S O 215299) . These sites were chosen because : -

(i) They were all in an area in which are to be found the highest blanket peats , the deepest peats and the most extensive and substantial peat deposits on the Black Mountains .

(ii) Since these three sites were separated by relatively short distances , it was felt that , even at these distances , significant differences might be found in their pollen spectra .

(iii) The three sites could also be compared with sites situated at longer distances , namely the Ty isaf and Pen y Gader - Fawr sites .

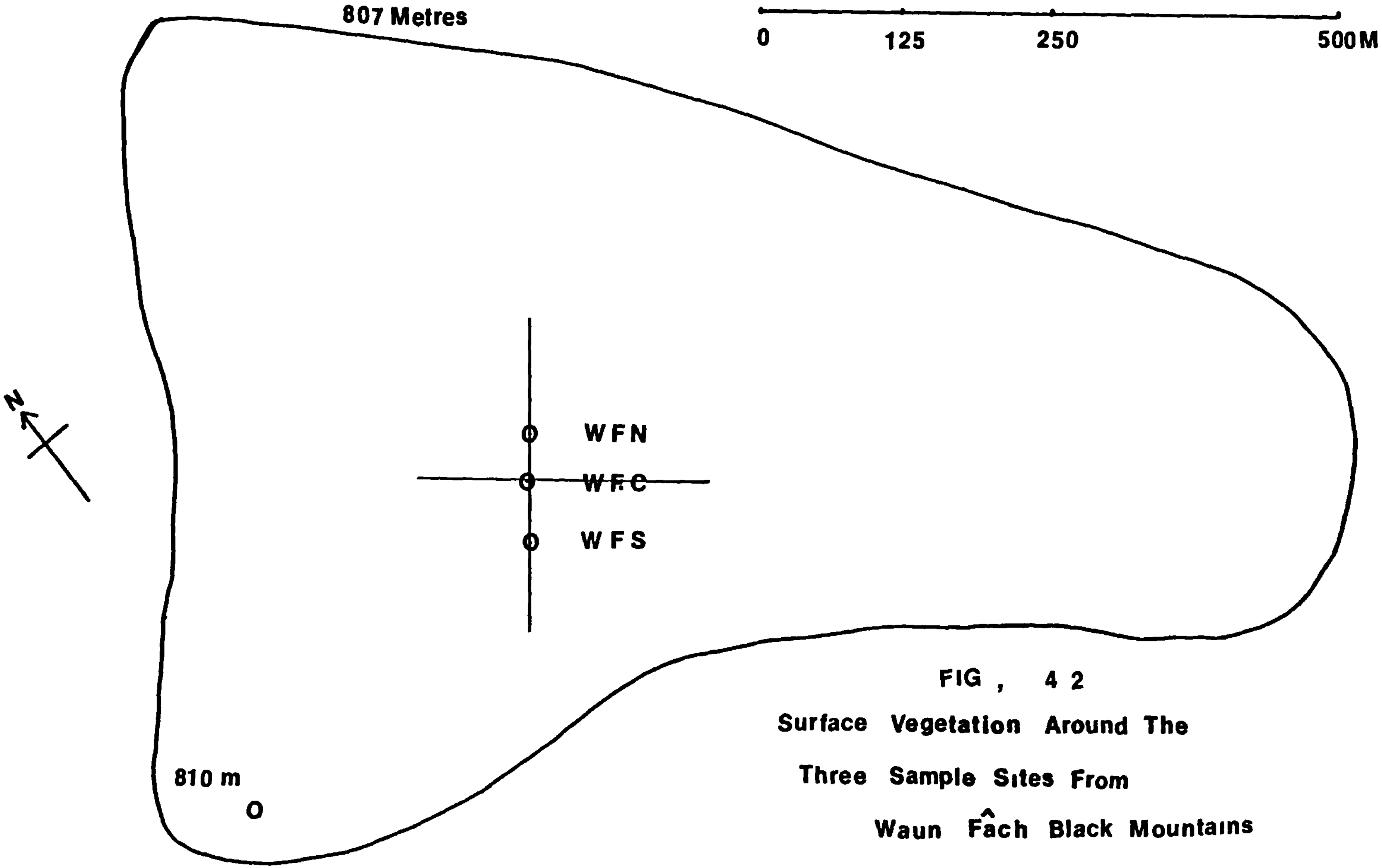


FIG , 4 2
Surface Vegetation Around The
Three Sample Sites From
Waun Fâch Black Mountains

THE METHODS USED TO REMOVE PEAT SAMPLES FROM THE SAMPLING SITES

4.5 Two methods were used to obtain representative samples of peat from the site locations: (1) by cutting out a peat monolith, and (2) by using a Russian borer to remove a core .

(1) The Peat Monolith

With a sharp spade a peat monolith was cut out in sections , approximately 20 cm by 20 cm square, by about 20 cm to 30 cm deep . This method was employed at the Ty-isaf, Pen y Gader-Fawr and Waun Fach south sites.

In order to cut out sections cleanly and in accurate contiguous succession, it was necessary first to dig a sizeable hole down to bedrock. From the face of this hole sections were then cut. Each section measured approximately 20 cm x 20 cm square and about 20 to 30 cm in length (depth). Great care was taken to ensure accurate continuity from one section block to the one below, so that the collected block sections made up a complete monolith. Each section was packed in polythene bags, sealed and labelled. Each pack was carefully padded to prevent disturbance during transport.

On the Ty-isaf site the total length of the monolith was 0.78 metres; this represented the full extent of the peat. Below the peat a layer of charcoal extended down for a further 3 cm A sample of this charcoal surface was cut out and placed in a polythene bag for radio-carbon dating.

At the Pen y Gader-Fawr site the monolith measured 1.16 metres. At the Waun Fach south site the monolith measured 2.50 metres.

(2) Russian Borer Cores

The Russian borer was used in sampling the Waun Fach central and north sites. By using extension rods and close parallel boring it was possible to

Plate 4.1

The Waun Fach summit in winter .

sample down to 2.44 m on the Waun Fach north site and to 2.30 m on the Waun Fach central site.

Each section of core collected in the Russian borer was 0.5 metres in length and was then extruded into a trough made by cutting a two inch diameter plastic drain pipe in half longtitudinally. Each trough section with its peat core was carefully bound in polythene, sealed and labelled.

THE LABORATORY PREPARATION OF PEAT SAMPLES FOR RADIO - CARBON DATING

4.6 All peat samples for radio-carbon dating were taken from the same monoliths from Ty isaf , Pen y Gader - Fawr and Waun Fach South that were used for pollen analysis .

Because of the small ratio of pollen to peat in the sample used , large samples of peat were required in preparation for radio - carbon dating . It was necessary therefore , to remove whole sections of the monolith , each section measuring approximately 16 x 16 cm square by 1.5 cm deep . On each monolith , sections were removed as follows : -

Each section or slice was removed by cutting with sharp stainless steel knives , which had been washed in distilled water and wiped clean with new paper towels and again washed with distilled water .

This work was carried out in the Geo-botany laboratory of the University of British Columbia with the kind permission of Professor Rouse . All laboratory glassware and equipment was scrupulously clean and free from any contamination by radio-isotopes . The process was as follows : -

(i) Small 2 cm cubes were next cut from a given slice of peat and batches of these were suspended in 10 % aqueous potassium hydroxide (Analar) in a 2 litre beaker and gently heated for several hours with occasional stirring to disperse any remaining lumps of peat .

(ii) The peat suspension was then placed in 50 ml centrifuge tubes and spun at 3,000 r.p.m. for several minutes , after which the supernatant liquid was poured away . The peat residues were re - suspended in distilled water . It was found necessary to repeat this procedure several times to remove all humic acids, i.e. until the supernatant liquid was colourless .

(iii) The residue was then washed thoroughly through a brass sieve , having a mesh size of 250 microns , in several batches using adequate volumes of distilled water . The filtrate was collected through a funnel into 100 ml centrifuge tubes and spun at 6,000 r.p.m. until a stable pellet was obtained .

(iv) The pellet was re-suspended in 10 % hydrochloric acid (Analar) and centifuged in 100 ml. tubes at 6,000 r.p.m. for 3 minutes . The process was repeated twice using distilled water instead of HCl .

(v) The residue was then examined under a dissecting binocular microscope. It was found that the residue consisted overwhelmingly of pollen grains and spores . With basal samples , there were , in addition , varying amounts of silicious and mineral particles .

(vi) The samples were then dried at 35°C in a thermostatically controlled oven then placed in polythene jars . The sample jars were then taken by car to the University of Washington in Seattle , Washington , and delivered to Professor A . W . Fairhall of the Department of Chemistry for radio - carbon dating , (see Chapter 5) .

LABORATORY PREPARATION OF SLIDES FOR POLLEN ANALYSIS

4.7 As a preliminary, each sectional block of peat from a monolith was cut on each lateral surface, thus reducing the approximate cross section from 20 x 20 cm to 16 cm x 16 cm and leaving an undisturbed square core section. At intervals along the length (depth) of each monolith sub-section, small 1 cm^3 blocks were cut, removed and placed in boiling tubes. With the Russian borer cores 1 cm^3 blocks were also removed at intervals along the core. These cubes were taken from a zone, slightly off the central line, to reduce contamination risks. These 1 cm^3 core blocks were also placed in boiling tubes, one block per boiling tube.

The intervals between successive cm. cubes varied with each monolith or borer core from 4 or 5 to 10 cm intervals. Towards the base of each monolith or core however, the intervals were shortened to 1 or 2 cm. This close, more frequent, sampling near the base was very necessary because of compaction in these older pollen horizons .

It should be emphasized that great care was taken, firstly to cut off the monolith lateral surfaces with clean straight-edged steel knives - using a clean knife for each surface, then the cubic centimetrs were cut and removed with the sharpened edges and tips of stainless steel and nickel spatulas.

The laboratory procedure for extracting the pollen from these small cm. cubes was as follows:-

THE EXTRACTION OF POLLEN SAMPLES FROM PEATS

4.71 The extraction procedures used were essentially the same as those procedures published in Moore and Webb (1978) and uring the acetolysis procedure as described by Erdtman G. (1963) . The only variations in apparatus was the use of a 120 microns aperture sieve in order to ensure retention of the large coniferous pollen ; eg. Abies sp. up to 100 microns .

An elastic test tube vibrator was also used for mixing thoroughly the final pollen extract before mounting on slides .

THE IDENTIFICATION AND RECORDING OF POLLEN AND SPORES

4.71 A Zeiss binocular microscope and an E. Leitz binocular microscope were used in this work. Both microscopes were fitted with phase contrast equipment and with calibrated mechanical stages. A calibration slide marked in microns was employed, when necessary, at all magnifications to measure pollen grain size. Pollen counts were taken by scanning the slide with several traverses at a magnification of X400. For more detailed examination a magnification of X1000 was found to be useful.

Seventy five arboreal pollen grains were counted one each of the two slides from each 1 cm^3 horizon, making a total of 150 arboreal grains for each horizon. In practice, large areas of each slide were covered in order to reduce errors .

All pollen grains and spores were counted. The presence of fungi and macrofossil fragments was noted.

Pollen keys in Erdtman, Praglowski, Nilsson (1963); Faegri and Iversen (1966); Kapp (1969), Moore & Webb (1978) were used in the identification of pollen types. In addition "type slides" from King's College, London were used . The counts were made at the University of British Columbia and at King's College . Plant nomenclature was that of Clapham , Tutin and Warburg (1962) .

4.8 PROBLEM POLLEN TYPES AND LIMITATIONS TO IDENTIFICATION

(i) CORYLOID POLLEN

The pollen of *Corylus avellana* and *Myrica gale* were united under the heading *Coryloid* pollen . Inspection revealed that the great majority of coryloid pollen grains were of *Corylus avellana*.

(ii) GRAMINEAE

The Cerealia are differentiated from the rest of the *Gramineae* by the size of the pollen grain which is taken as greater than 40 micrometres in diameter in the Cerealia , Faegri & Iversen , (1966). Generic differentiation between the two groups was not attempted.

Note : all other pollen types were separated , using the pollen key in Moore, P.D. and Webb, J. (1979) .

THE PRESENTATION AND EXPRESSION OF POLLEN RESULTS

THE POLLEN DIAGRAMS

4.9 The results of the pollen analysis of the peat samples from the Black Mountains are expressed in two ways:-

(i) Total Arboreal Pollen

The pollen diagrams of the Black Mountains sites are expressed as a percentage of total arboreal pollen (T.A.P.)

(ii) Total Pollen

With the Black Mountains' blanket peat it was advantageous to differentiate between regional and local pollen, since local pollen was generally over-represented in the total pollen. The pollen from local plant families such as the Gramineae, Cyperaceae and Ericaceae are therefore expressed as a percentage of total pollen (T.P.) in addition to being expressed as a percentage of total arboreal pollen (T.A.P.).

The use of these two methods to express pollen counts is designed to show the overall pattern of changes in the pollen at different horizons .

CHAPTER FIVE

POLLEN SITE DESCRIPTIONS

5.1

Brief descriptions of the pollen sites is as follows : -

Waun Fach South , Central and North .

5.2 Summit altitude : 810 metres .

Sample altitude : 806 metres .

Features of the site : An extensive shallow baisin draining mainly eastwards into the Grwyne Fawr valley .

Pollen profile depths : 250 , 244 and 230 cm . respectively .

Pen Y Gader - Fawr .

Summit altitude : 801 metres .

5.3 Sample altitude : 760 metres .

Features of site : Located on gently sloping ground on the edge of the peak , prone to some downwash . Forms part of an extensive blanket peat .

Pollen profile depth : 116 cm

Ty isaf .

Summit altitude : 701 metres .

5.4 Sample altitude : 650 metres .

Features of site : Located on the top and end of a very narrow ridge .

Pollen profile depth : 72 cm

RADIO - CARBON DATES FROM THE PEAT MONOLITHS ON PEN Y GADER - FAWR , TY ISAF AND WAUN FACH SOUTH

5.4

As mentioned in chapter 4 , sections 4.1 to 4.4 , a number of horizons were selected from three monoliths for radio-carbon dating as follows :

(i) RADIO - CARBON DATES FROM PEN Y GADER - FAWR .

5.41 This profile has been radio-carbon dated on two horizons ; the first just above the base of the profile at 105 cm depth and the second at 75 cm depth. The dates are 3525 ± 100 years b.p. and 2535 ± 115 years b.p. respectively . The date at the base places peat initiation at 3876 extrapolated years b.p. , (uncorrected dates).

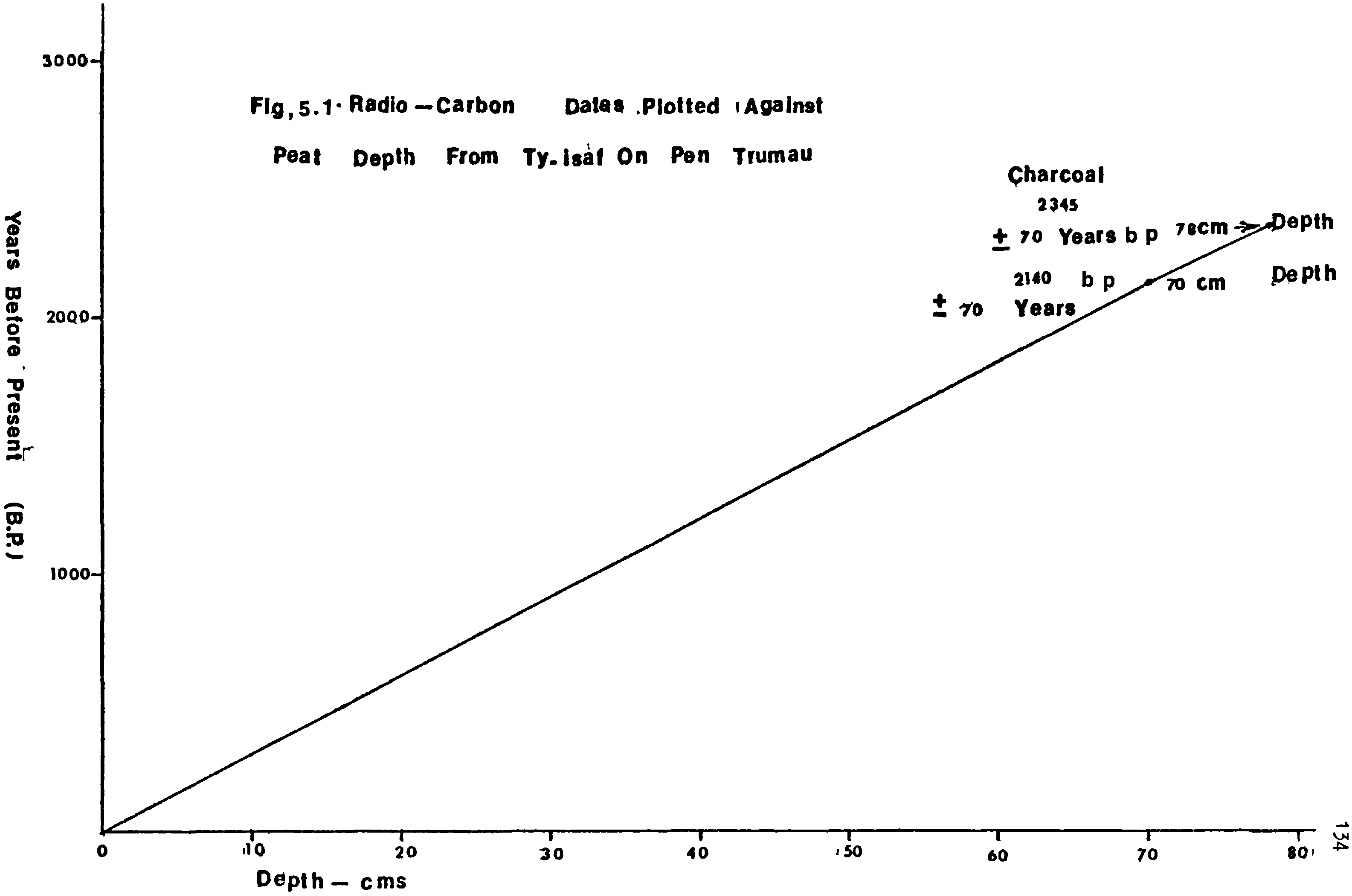
(ii) RADIO - CARBON DATES FROM TY ISAF , PEN TRUMAU .

5.42 This profile has been radio-carbon dated on two horizons both at the base of the profile . The first , a charcoal layer at 78 cm depth ; the second at 70 cm. from the overlying peat . The dates are 2345 ± 70 years b.p. and 2140 ± 70 years b.p. respectively , (uncorrected dates) .

(iii) RADIO - CARBON DATES FROM WAUN FACH SOUTH .

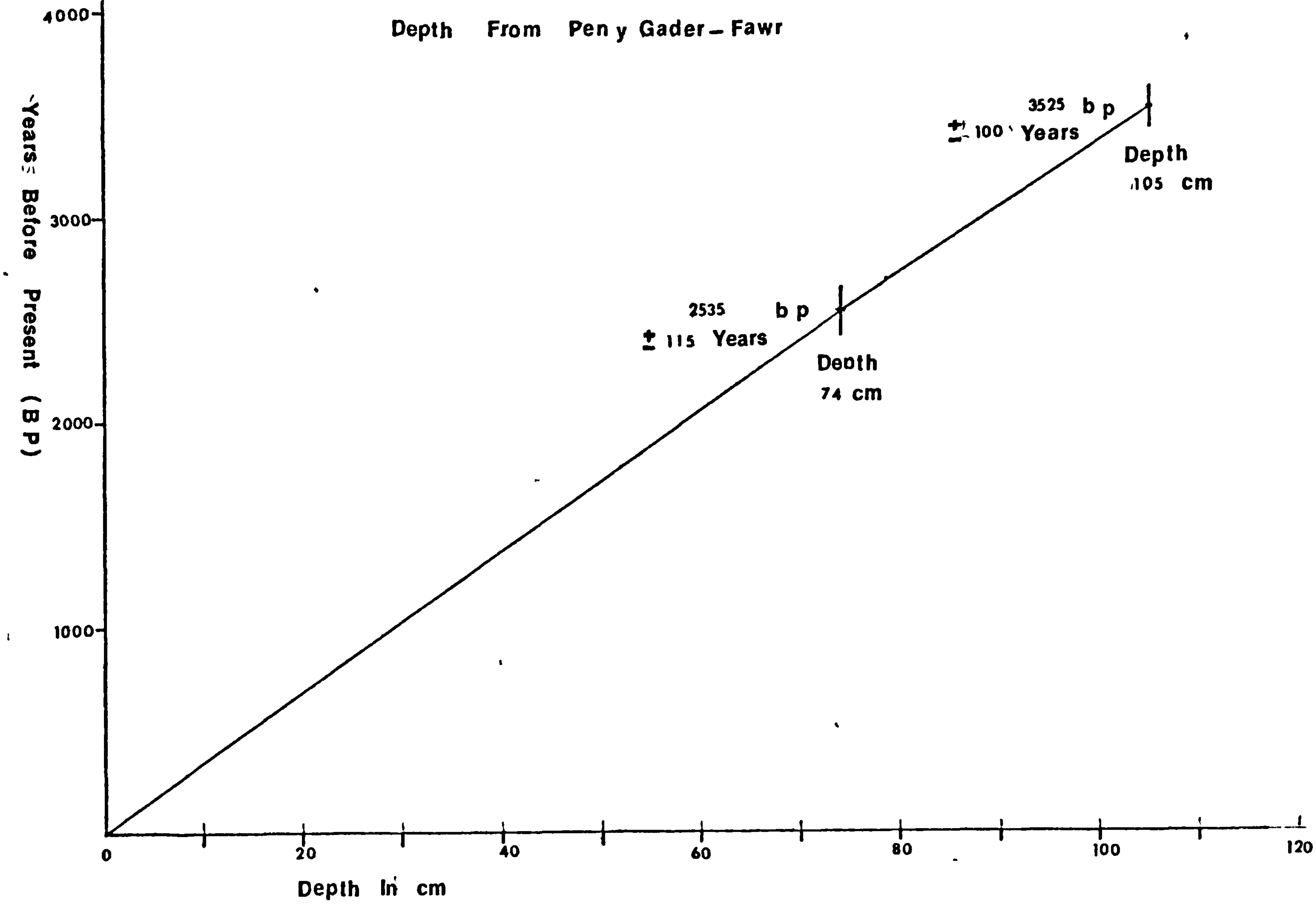
5.43 This profile had three radio-carbon dates at 243 cm , 196 cm , and at 94 cm The dates for these horizons are 4830 ± 55 years b.p. , 2835 ± 110 years b.p. and 1550 ± 75 years b.p. respectively , (uncorrected dates) .

The radio-carbon dates from each of the monoliths from Waun Fach South , Pen Y Gader-Fawr and Ty isaf are plotted in Figures ; 5.3 , 5.2 , and 5.1 respectively against peat depth .



Fig, 5.1· Radio — Carbon Dates Plotted Against Peat Depth From Ty-isaf On Pen Trumau

Fig 5·2 Radio – Carbon Dates Plotted Against Peat
Depth From Pen y Gader – Fawr



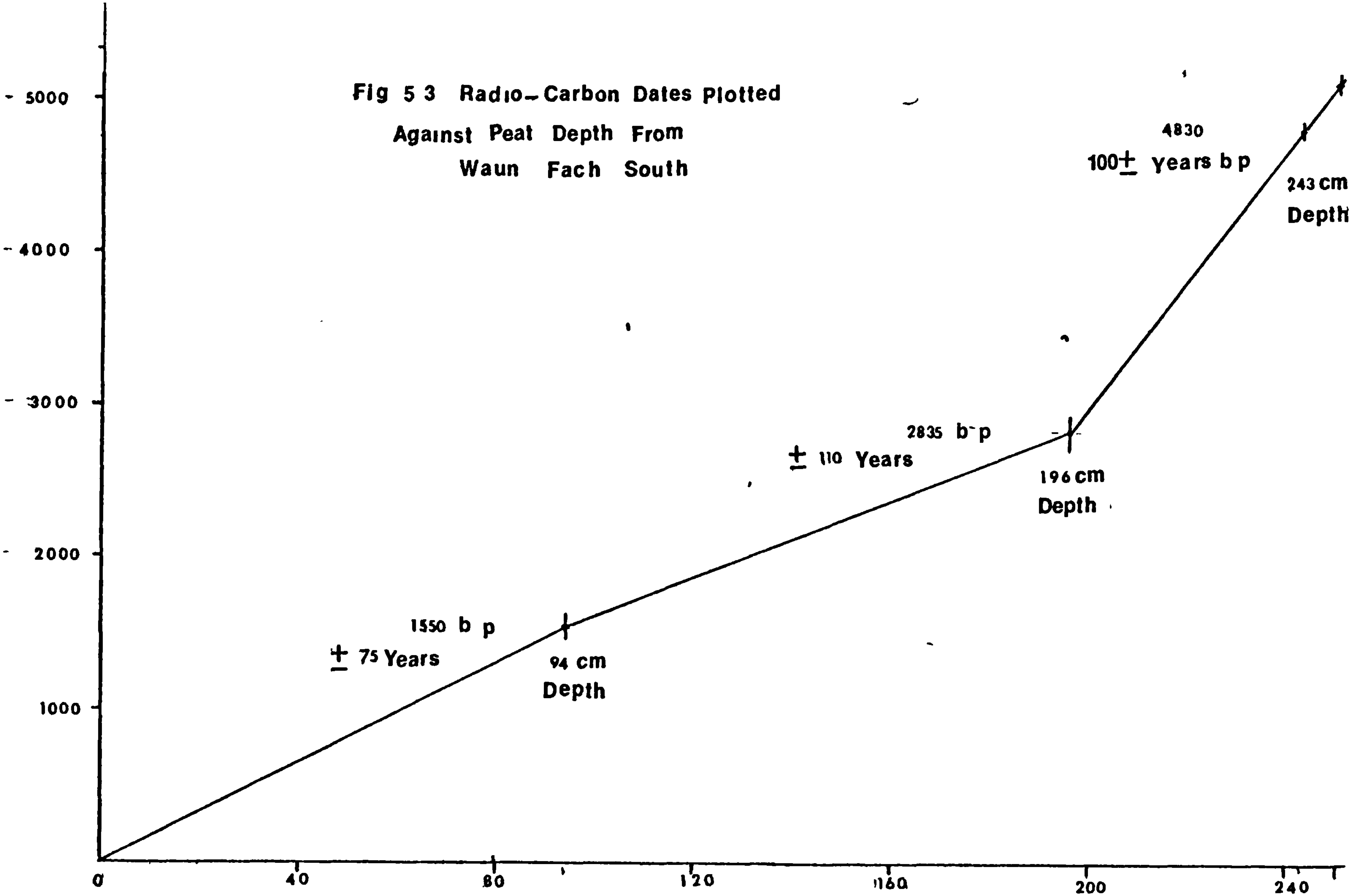


Fig 5 3 Radio-Carbon Dates Plotted Against Peat Depth From Waun Fach South

PEAT ACCUMULATION RATES AT THE BLACK MOUNTAINS POLLEN SAMPLING SITES

5.5

Peat accumulation rates have been calculated for each zone in the Waun Fach South , Ty isaf and Pen y Gader - Fawr profiles by using the radio-carbon dates for each profile (tables 5.1 ; 5.2 and 5.3) . The rate of peat growth is expressed as years per centimetre .

Average rates of peat growth on the Waun Fach Central and North pollen have been calculated by reference to the comparable zones and radio - carbon dates on the Waun Fach profile .

In all three tables ; 5.1 ; 5.2 ; 5.3 , the calculations for peat growth are based on a constant rate of sedimentation and do not compensate for compression in the lower layers due to the weight of the overlying peat .

TABLE 5.1

THE AVERAGE RATE OF PEAT GROWTH ON THE WAUN FACH SOUTH PROFILE

Zones on W.F.S	Peat depth in cm	Extrapolated years b.p.	Rate of peat growth/annum, cm
W.F.S. 9/10	22	363	16.49
" 8/9	40	650	16.49
" 7/8	70	1154	16.49
" 6b/7	90	1484	16.49
Radio-carbon dated	94	1550	—
W.F.S. 6a/6b	140	2130	12.6
" 5b/6a	159	2369	12.6
" 5a/5b	173	2545	12.6
Radio-carbon dated	196	2835	—
W.F.S. 4/5a	201	3047	42.45
" 3/4	214	3600	42.45
" 2/3	227	4150	42.45
" 1/2	234	4448	42.45
Radio-carbon dated	243	4830	42.45

Note: * Extrapolated date for peat initiation = 5127 years b.p. at ~250 cm

* Due to compression, the apparent rate of peat growth is reduced in the lower layers.

TABLE 5.2

THE AVERAGE RATE OF PEAT GROWTH ON THE TY ISAF PROFILE

Zones on Ty isaf	Peat depth in cm	Extrapolated years b.p.	Rate of peat growth/ annum, cm
T 4/5	18	1550	30.57
T 3/4	25	764	30.57
T 2/3	38	1162	30.57
T 1/2	50	1529	30.57
[Radio-carbon dated]	70	2140	—
T1	71	2163	25.63
[Radio-carbon dated]	78	2345 charcoal	—

TABLE 5.3

THE AVERAGE RATE OF PEAT GROWTH ON THE PEN y GADER-FAWR PROFILE

Zones on P.Y.G.F	Peat depth in cm	Extrapolated years b.p.	Rate of peat grwth/annum, cm
P 4/5	22	754	34.26
P 3/4	34	1165	34.26
P 2/3	63	2158	34.26
[Radio-carbon dated]	74	2535	—
P 1/2	100	3365	31.94
[Radio-carbon dated]	105	3525	—

NOTE : Due to compression , the apparent rate of peat growth is reduced in the lower layers .

CHAPTER 6

DATING OF THE BLACK MOUNTAINS PROFILES

All Black Mountains pollen profile horizons were dated by comparison with the 7 radio - carbon dates of the three profiles , Waun Fach South , Pen y Gader - Fawr , Ty isaf . Any extrapolated dates have given a variety of inherent errors , for example ; radio - carbon laboratory errors , or , the assumption that the rate of peat sedimentation is constant .

In this study the date of any horizon was calculated by dividing the number of horizons (cm) into the difference between the two radio - carbon dates . This results in apparently very precise dates . But in reality , each date may be ± 50 - 100 years or more .

STRATIGRAPHY

The key for the stratigraphy of the pollen profiles (i.e. 6.51 - 54 , 6.61 - 64 , 6.71 - 74 , 6.81 - 84 and 6.91 - 94) , is given in appendix Tables , 6.4 to 6.9 inclusive .

For abbreviations used in the following chapters see Appendix 6 .

Pollen characteristics of each profile , for each zone is given in Appendix No 8 to 12 inclusive .

DISCUSSION OF THE TY ISAF POLLEN PROFILE ON THE PEN TRUMAU RIDGE , BLACK MOUNTAINS

6.50 The profile has been divided into a number of zones , T - 1 to T - 5 as follows : -

Section	Zone	Peat depth in cm	Extrapolated years b.p.
6.56	T - 5	10 t0 18	300 to 550
6.55	T - 4	18 to 25	550 to 760
6.53 to 6.54	T - 3	25 to 37	760 to 1130
6.52	T - 2	38 to 49	1160 to 1500
6.51	T - 1	50 to 72	1530 to 2700

See Figures 5.51 to 5.4 inclusive .

At the base of the whole peat profile there was a layer of charcoal which was radio-carbon dated at 2345 ± 70 years b.p. at 78 cm horizon . A second radio-carbon date 2140 ± 70 years b.p. was taken from the peat monolith at a depth of 70 cms. , 8 cm above the base .

The radio-carbon dates places the initiation of the profile in the Iron age . The intervening layers between 78 and 72 cm . contained very low concentrations of pollen and showed strong erosion of pollen grains , this made identification impossible .

The profile starts off with an overwhelming abundance of Filicales pollen , followed by <u>Corylus</u> , Ericaceae , Polypodiaceae in descending order of abundance , ERICACEAE suggestive of a heather heath nearby in the vicinity (see Figure 6.52) .

ZONE T - 1 , 72 TO 50 cm .

6.51 The picture for arboreal pollen shows Ulmus regenerating as Tilia decreases slightly , with Tilia T.A.P. levels more than double the Ulmus levels (over 20 % T.A.P.) . Ulmus peaks at the 70 cm horizon ,.At 1 cm below this level there is a total shrub pollen peak of 43 % (omitting most local pollen) . Gramineae is noted for its absence in this portion of the diagram . Quercus , Betula , and Alnus are all fairly stable up to the 70 cm horizon . The absence of Plantago , Gramineae and the low ruderal counts suggest an absence of any clearance at this portion of the profile* (see Figs. 6.51 to 6.53).

From 70 cm onwards Ulmus and later Tilia decline . Corylus declines steadily and Betula also declines sharply to the advantage of Quercus . Alnus increases and peaks at the first Plantago lanceolata peak at 66 cm with ruderals increasing . This initial period indicates an early selective clearance of Tilia and Ulmus accompanied by Corylus as an understory shrub . Later , as woodland thinning continues , Corylus levels rise slightly as the canopy opens and allows better Corylus pollen dispersal .

At the Plantago lanceolata peak at 66 cm Ulmus and Tilia are not recorded but reappear in the next horizon . A second , small recovery phase starts at 64 cm This is accompanied by increasing Betula and Corylus indicating a continued woodland thinning . Indeed , both Quercus and , to a lesser degree , Alnus do decline , particularly at the Ulmus and Pinus peak (Pinus recurs at the 62 cm horizon) , see Fig. 6.51 .

Another Ulmus clearance phase follows, which is far greater in intensity . Initially Ulmus , Betula and Corylus decline , at the time of the maximum Plantago lanceolata peak . Gramineae increase with Plantago, with cereals being first recorded at this point in the profile . Ruderals also increase in frequency and magnitude .Quercus peaks with the main Plantago peak at 58 cm

* See appendix , Table 6.2 .

6.51 (Iron age - Roman period) and then declines sharply .

On Ty isaf the initial clearance of Ulmus , Tilia and Betula is followed by decreasing Quercus levels . An increase in ruderals , Gramineae , Plantains ; (Plantago major-media peaking after Plantago lanceolata) and Ericaceae are indicative of large scale and long periods of local valley clearances.

Pastures for grazing are indicated by Plantago lanceolata and Gramineae increasing substantially ; whereas cleared land for crop production is indicated by rising levels of Plantago major-media and cereal pollen*.

Indeed from the location of Iron age enclosures on lower hill sides and land spurs all in lowland positions , it appears that clearances for crops would have been mainly in the valley and on lower hill slopes (see Fig. 7.21).

The presence of the charcoal layer at the base of the peat , the profusion of hill forts (which indicate human presence) , the presence of pollen indicators of human presence such as Plantago lanceolata , Plantago major - media , ruderals , cereals and Pteridium , all suggest that man interfered with the upper levels for grazing purposes .

As clearance activity reduces Betula , Fraxinus and Corylus recolonize open cleared areas as well as areas cleared of Quercus , Ulmus and to a lesser degree of Alnus . The period closes at 50 cm with an increase in total tree percentages to 34 % T.P. and with Betula as the dominant genus . It should be noted that Corylus had been declining throughout this clearance phase which indicates the intensity of clearance .

The dramatic fall in Gramineae , ruderals , Plantains and ericaceous plants is a further indication of a lull in clearance activity*. This period of clearances lasted from 2345 ± 70 years b.p. (366 B.C.) to 1530 years b.p. (450 A.D.) at 50 cm totalling 816 years , with the main clearances occuring over a period of 700 years .

* See appendix , Table 6.2 .

ZONE T - 2

49 to 38 cm , 1500 to 1160 extrapolated years b.p.

49 to 45 cm 1500 to 1380 extrapolated years b.p.

6.52 This portion of the profile represents a renewed clearance phase with total tree pollen levels declining sharply . Betula makes the largest losses but regenerates at the upper horizons . Ulmus actually regenerates slightly between two Plantago lanceolata peaks . Betula ,which recolonized previously open lands, was first to be removed . Corylus, after an initial increase as a recolonizing understory shrub,decreases at the top of this portion of the profile, indicating clearances of the main tree components . At 44 cm ruderals start to increase and Ericaceae increases sharply initially , then maintains this level at the 43 cm. .

44 to 38 cm , 1350 to 1160 extrapolated years b.p.

6.52 This portion of the profile extends to the end of the zone at 38 cm which represents an arboreal regeneration (34 % T.P.) . In the cleared areas and possibly open woodland areas, Fraxinus regenerates as a pioneer species after the 44 cm plantain peaks , There then follows a mild clearance phase at 40 cm with a plantain peak and with Gramineae increasing , followed by Fraxinus . There is also a regeneration of Ulmus and an increased occurrence of Quercus .

Corylus levels are down but probably only as a result of canopy closures . At the close of the zone both Alnus and Quercus have increased but with Ulmus declining slightly in the damp woodlands of the Rhian goll valley .

ZONE T - 3

37 to 25 cm. 1130 to 760 extrapolated years b.p.

6.53 This zone represents another major clearance phase beginning particularly between 35 cm and 29 cm . from 1070 to 880 years b.p. Betula drops severely as Plantago sp. increase . Quercus as in the Iron age - Roman period clearance phase T - 1 peaks with Plantago , but Alnus this time declines rapidly as the clearance phase continues .

Ulmus regenerates at the Plantago peak at 34 cm. , 1040 years b.p. Gramineae increases steadily , peaking after Plantago sp. at 29 cm. , a rise from 23 % to 28 % T.A.P. The Plantago lanceolata in this area peaks at 34 cm . , with 149 % T.A.P. Ruderals show a marked increase in this clearance phase with Umbelliferae , Compositeae and Anthemis type having their highest levels in the profile .

Plantago major - media peaks after the Plantago lanceolata , indicating arable clearances followed the pastoral maxima 34 cm

6.54 From the evidence in section 6.53 it is clear that a major clearance , probably quite local (The Rhian goll valley below Ty isaf) , took place , in which relatively large areas of land were cleared for grassland grazing as well as for crop production . Marginal Alnus and some Corylus were felled as well as Betula , during this clearance .

The Ulmus and Pinus regenerations occured on marginal pasture lands on valley slopes . As clearance activity decline Betula and then Fraxinus regenerate with Betula peaking as Alnus reached a low , and with Fraxinus attaining its highest levels in the profile . This sequence of Betula regeneration followed by Fraxinus is a reflection of " its temporal position in successional sequences " , with Betula occupying a " pioneer position in succession " (Moore P.D. and Bellamy D.J. , 1974) .

Once again, the magnitude of the *Fraxinus* regeneration in particular is indicative of the intensity of clearance and the amount of land to be recolonised . Gramineae , ruderals , *Plantago sp.* and related clearance indicators of human activity* all reduce , with a continuation in the decline of *Corylus* .

The reduction in *Corylus* may be due partly to the closing of the woodland canopy component , thus restricting the understory shrubs' pollen dispersal . T.A.P. levels peak at 25 cm when Gramineae , *Plantago sp.* , and ruderal levels are low .

It should be pointed out , that from the 37 cm horizon upwards , the local components, such as Gramineae, *Sphagnum* and particularly Ericaceae , contribute very significantly to the total pollen percentage so that T.A.P. percentages should be regarded with caution .

* See appendix , Table 6.2 .

ZONE T - 4

25 to 18 cms. 760 to 300 extrapolated years b.p.

6.55 On the local pollen level Gramineae decreases steadily to a low at 23 cm . while Ericaceae continues to dominate the pollen spectrum . Sphagnum has a massive peak at 24 cm . (700 years b.p.) , indicating wetter local conditions . The high Ericaceae levels indicate that the lower slopes , towards the Rhian goll valley , were dominated by ericaceous plants , particularly at the 20 cms. horizon .

Plantago climbs initially to a small peak at 24 cm . (200 years b.p.) , but it is not until 19 cm (600 years b.p.) , that a major peak occurs , together with a simultaneous increase in ruderals . This indicates another major upsurge in clearance and grazing activity . Gramineae , although depressed , show a small peak in this region .

Arboreal trends are mixed from the 25 cm to the 18 cm horizon . Betula rises with a broad peak between the two Plantago lanceolata peaks at the 23 and 19 cm horizons and then falls slightly . Pinus maintains its levels at 23 cm . when Ulmus reappears . Quercus rises steadily and peaks after the main plantain peak , at 19 cm . , then declines slightly afterwards . Alnus follows a parallel but opposite course to Quercus . Corylus becomes level after falling to a low at 18 cm.

Zone T - 4, represents varying degrees of clearance and regeneration . The initial reduction in tree pollen is followed by a Plantago lanceolata peak indicating clearance for pastoral purposes . The sudden increase in Gramineae and Plantago lanceolata at 20 and 19 cm respectively indicates a further intensification of clearance . This is also reflected by diminishing T.T.P. values with decreasing depth .

The reduction in *Pinus* and *Alnus* and the continued reduction of *Corylus* indicate clearances of these genera in wet valley bottoms and on hillside gulleys . The arable agricultural indications present at 19 and 18 cm suggest clearances at lower elevations probably,in the Rhian goll valley bottom.

ZONE T - 5

18 to 10 cm . 550 to 300 extrapolated years b.p.

6.56 Clearances for pastoral agriculture at 14 cm , involved the removal of *Alnus* and *Fraxinus* from open and woodland area in the Rhian goll valley . The partial regeneration of *Ulmus* and *Pinus* may well suggest a shifting pastoralism away from previously - cleared lowlands .

Alternatively,there could have been hedgerow regenerations of these genera. The later clearances of *Quercus* and *Betula* at the 10 cm horizon , occur at a time of marginal scrub expansion and of a rise in the level of arable pollen indicators including cereals .

This increase in arable clearance probably reflects increased population pressures and a greater utilization of cereals in the daily diet . This zone in general shows less vegetational disturbances than either the Zone T - 1 ,or Zone T - 3 .

FIG. 6.51

Pollen Diagram from TY-ISAF, Black Mountains

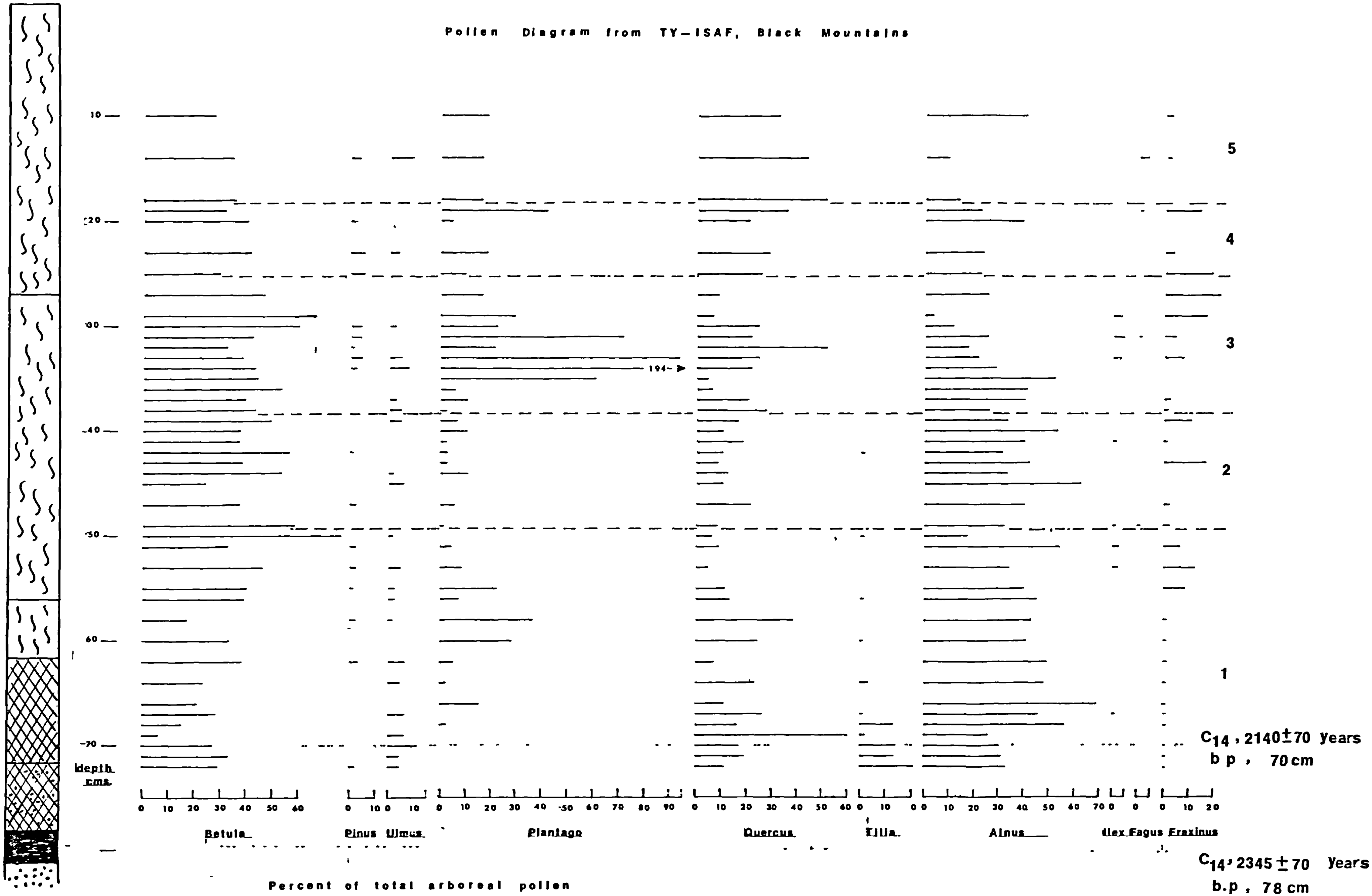


FIG. 6.52

Pollen Diagragram from TY ISAF, Pen Trumau, Black Mountains.

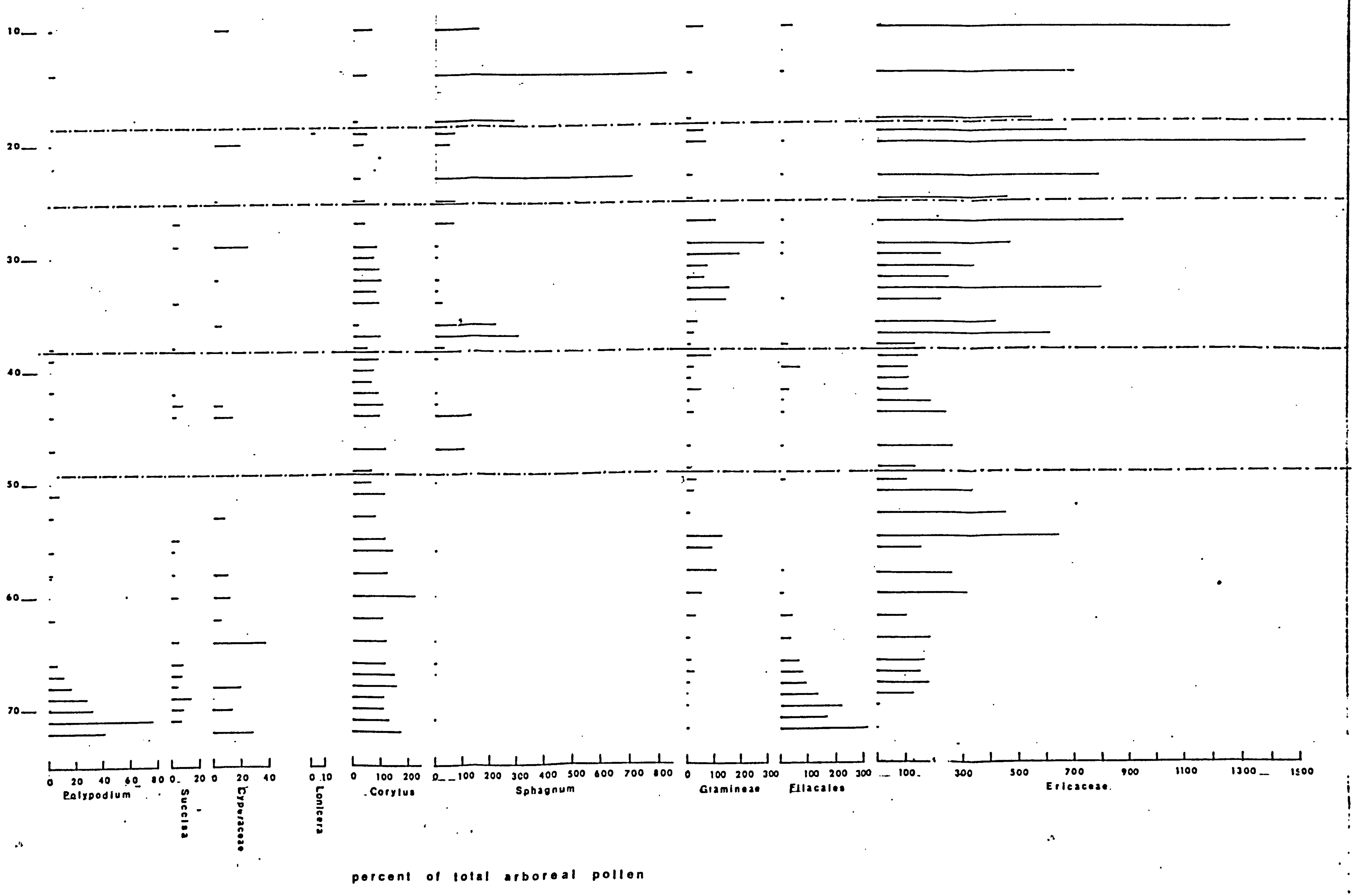


FIG. 6 53

Pollen _ Diagram from _ Ty Isaf, Black Mountains

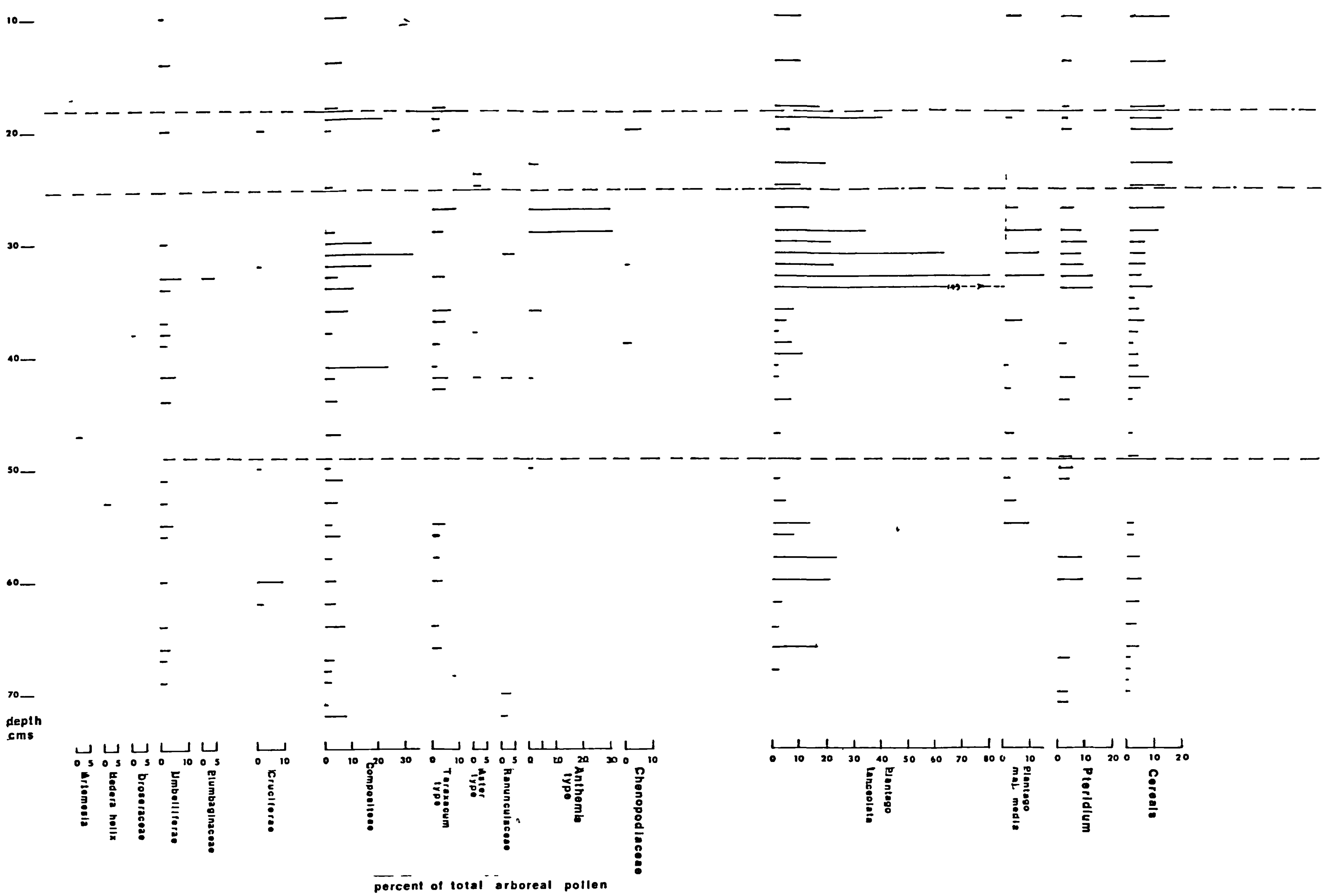


FIG. 6.54 POLLEN DIAGRAM FROM TY ISAF, PEN TRUMAU, BLACK MOUNTAINS

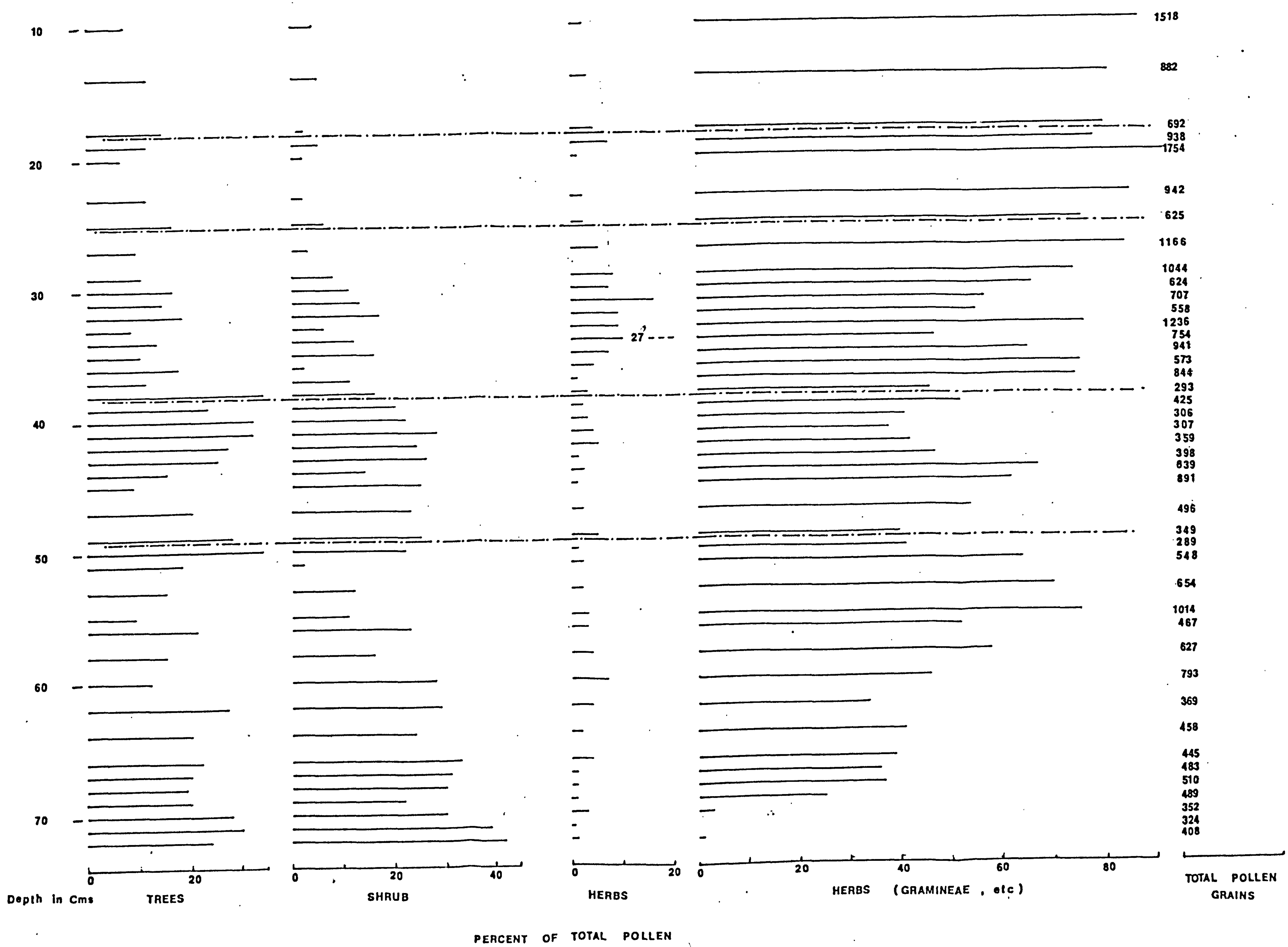


Plate 6.2

Vegetation cover of lower hillsides showing Alnus growing along stream banks in Rhian goll valley .

FIG. 6.54 POLLEN DIAGRAM FROM TY ISAF, PEN TRUMAU, BLACK MOUNTAINS

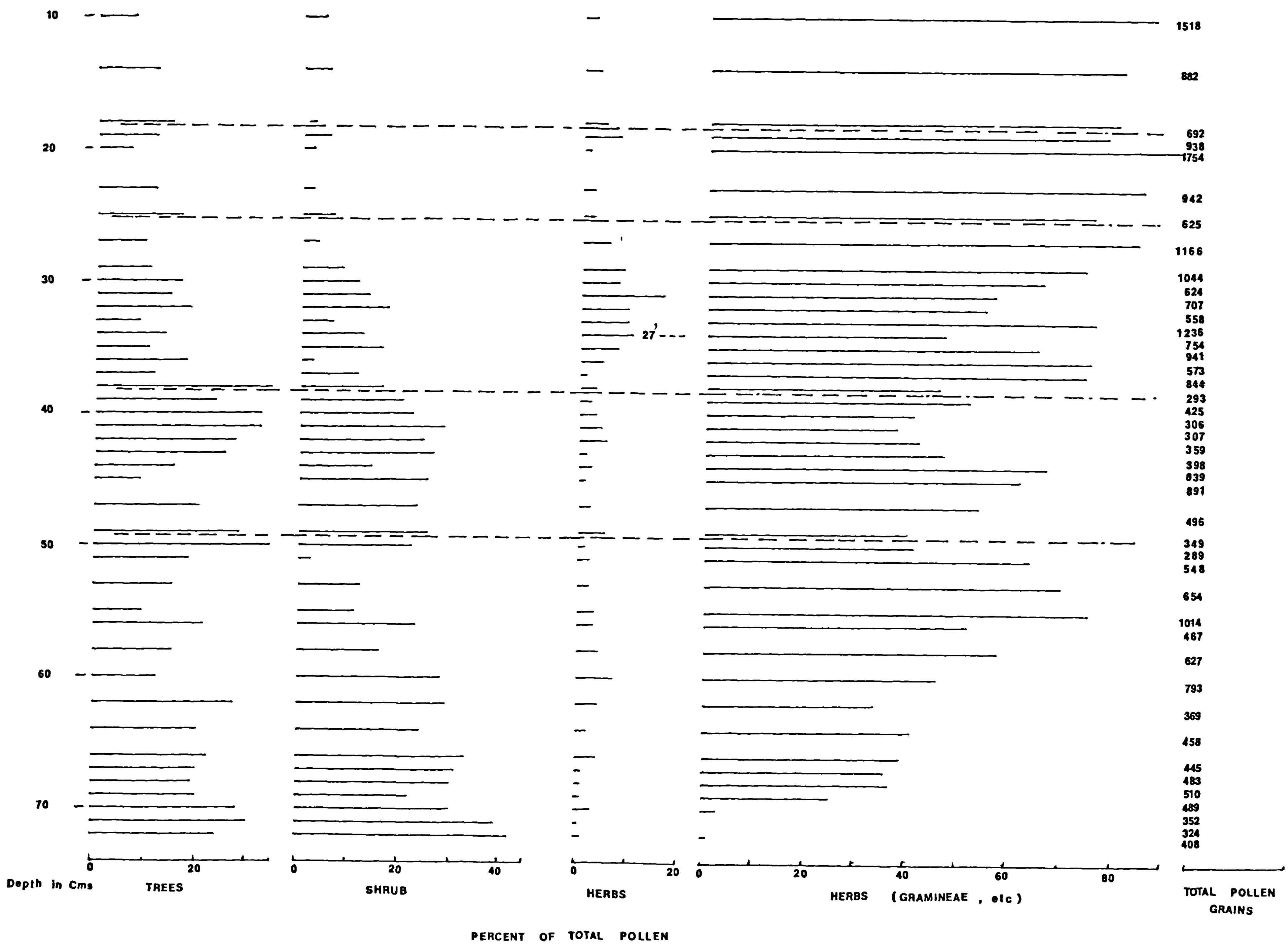


Plate 6.4

Pen y Gader - Fawr summit viewed from the west . SO 229288 .

The Pen y Gader - Fawr fossil pollen profile was taken from peats on the slopes of the peak .

ZONE G - 1

116 to 101 cm . 3900 to 3400 extrapolated years b.p.

6.61 This zone records the gradual regeneration of Ulmus and Betula lasting nearly half a millenium .

The absence of Betula pollen in the base of the profile is of particular interest . This may have been due to a total clearance of the genus from the Pen y Gader - Fawr summit .

It is very probable that Betula did grow on the summit before peat initiation because pieces of Betula and Quercus were discovered at the base of the peat on the top of the Gader (Pen y Gader - Fawr) mountain , (SO . 229288) , Blundell G.E. , (1939), (Wheeler , 1939) .

This suggests that Betula was growing in the vicinity . It follows therefore , that Betula must have been removed before the basal peat layers were laid down . This also suggests that no regional Betula pollen was arriving at the Pen y Gader - Fawr profile site . This may also have been true for the remainder of the Pen y Gader - Fawr profiles .

The first appearance of Plantago lanceolata is at the 111 cm horizon , 3700 extrapolated years b.p. , coinciding with clearances of Alnus , Quercus and Tilia . At the 101 cm horizon , Betula , Quercus and Ulmus are all regenerating . Local pollen components , Ericaceae , rose sharply at this horizon while Gramineae declined considerably , suggesting a decrease in grasslands and increasing heathlands of upland areas of Llanbedr valley .

ZONE G - 2

100 to 64 cm , 3360 to 2200 extrapolated years b.p.

6.62 A sharp decline in *Ulmus* occurs 3300 extrapolated years b.p. at the 99 cm horizon . This is followed approximately 96 years later by a second abrupt fall at the 96 cm horizon . Finally , *Ulmus* was reduced almost to extinction shortly after 92 cm . , 3100 years b.p. (extrapolated).

Quercus declined between 98 and 92 cm Both *Tilia* and *Betula* were cleared after 92 cm , and both genera were cleared again at the 83 cm horizon , this time to apparent extinction . *Corylus* also declined during these intensive clearances and fell to a low level at the 79 cm horizon .

In all these clearances , there is a continued increase in *Plantago lanceolata* which rises to a peak between the 83 and 79 cm horizons . Local pollen components such as Gramineae and , to a greater extent , Ericaceae , increase during these clearances .

A profusion of ruderals , indicative of cleared ground accompany the *Plantago lanceolata* increases , and reach very high T.A.P. percentages at these same horizons (83 and 79 cm .) . *Plantago major-media* also makes a substantial showing at the 83 and 79 cm , horizons . This evidence together with cereal grains found at the 71 cm horizon indicate arable agricultural clearances at the same time as pastoral clearances,Turner.J.(1965).

Clearances decline to a low level at the 74 cm. horizon but start increasing to a shallow peak of *Plantago lanceolata* at 67 cm . , and then decline at the zone boundary of 64 cm. Despite this clearance activity , *Ulmus* , *Betula* and *Quercus* regenerate up to the 64 cm horizon .

To summarize , Zone G - 2 , records one major clearance phase between the 100 and 74 cm horizons followed by a smaller clearance phase between 74 and 64 cm .

The date of these first clearances , 3360 extrapolated years b.p. , encompasses the middle Bronze age . The peak clearance activity is during the late Bronze age . The location of these clearances was mainly on the high western ridge , which forms the watershed of the Llanbedr valley . In addition , there are some further clearances of parts of the western watershed of Pen y Gader-Fawr .

The clearances for arable agriculture were probably located at the mou th of the Llanbedr valley where the lowlands are , more or less , level . The second smaller clearance phase between 2500 and 2200 extrapolated years b.p. (74 to 64 cms.) , occur over smaller areas and thus allowed Ulmus and Betula gradually to regenerate . This later clearance encompasses part of the Iron age (see section 7.2) .

The continuing profusion of ruderals indicative of open ground clearances and the presence of cereal grains suggest that a proportion of these clearances were for arable agriculture . The location of clearances was probably in the vicinity of the Iron age hill fort Crug Hyell (see Fig. 7.21) , at the mouth of the Llanbedr valley .

ZONE G - 3

63 to 34 cm 2160 to 1160 extrapolated years b.p.

6.63 This zone includes the largest clearance phase in the whole profile . Ulmus and Quercus are gradually cleared , initially up to the 55 cm horizon . Then Ulmus is severely cleared to apparent extinction just above the 51 cm horizon . Quercus declines to a low level at 38 cm Alnus is only cleared at the clearance peak at 51 cm .

Corylus , initially appears to expand , as the lack of woodland canopy allowed Betula seedlings to germinate, Corylus and Betula increase up to the 51 cm horizon, but,as clearances continued Corylus was also cleared at 46 cm horizon. This clearance is again followed by a very substantial regeneration and expansion of Betula up to 38 cm

Betula was later overshadowed by the arboreal regeneration which followed at the 34 cm horizon . During this zonal period Ericaceae and Gramineae expanded as clearances intensified and declined as clearance activity declined , indicating substantial increase in grazing areas and heathlands.

The large pastoral expansion was accompanied by a smaller increase in arable agriculture with Plantago major-media being recorded between the 55 and 42 cm horizons . Cereal grains were recorded over an even larger period . Ruderals indicators of ground disturbances* (both pastoral and arable) , had lower T.A.P. percentages during the previous zone , G - 2 .

Pinus occurs sporadically in this zone and does regenerate during maximum clearance activity on dry hillsides away from clearance areas . Ulmus and Tilia show signs of regeneration at the 42 cm horizon , but suffer additional declines at 38 cm The genera do recover however , and regenerate partially with Quercus and Ulmus at the 34 cm zone boundary .

* See appendix , Table 6.2 .

To summarise , Zone G - 3 , encompasses the end of the Iron age , the subjugation of the Silures by the Romans , the whole of the Roman occupation , and up to , possibly , the early 9th century A.D. (1160 extrapolated years b.p.) .

The significance of the palynological findings , set against the historical background , are discussed in section 7.2 .

The location of the extensive clearances in Zone G - 3 , is almost certainly centred around the mouth of the Llanbedr valley where the Crug Hyell hill fort is located . Upland grazing was probable , mainly on the ridges of lower altitude towards the mouth of the Llanbedr valley, (see Figures 7.21 and 6.110) .

ZONE G - 4

34 to 22 cm . 1160 to 750 extrapolated years b.p.

6.64 This zone has a lack of clearance activity , during an historically active period . Small *Plantago lanceolata* and *Plantago major-media* peaks occur at 30 cm , together with the appearance of cereal grains and ruderals ; all indicative of floristic disturbances .

This resulted from the clearance of *Tilia* , *Ulmus* and *Quercus* . There was a slight expansion of *Corylus* due probably to improved pollen dispersal efficiency . Despite the lack of clearance activity T.A.P. percentages do not show much change .

Pinus , *Quercus* , and *Alnus* do regenerate slightly with *Betula* showing substantial growth at the 22 cm horizon .

This period,historically, includes a span of two centuries before the Norman conquest in Wales and continues to the early 13th century , well within the period of Norman occupation .

The low incidence of clearance activity in this zone suggests a small population within the area represented on the Pen y Gader-Fawr profile . Following the small clearances at 30 cm (possibly the early 11th century) , the area of the Llanbedr valley may well have been set aside as hunting reserve for the local lordship . This is discussed in section 7 . 1 .

ZONE G - 5

- 22 to 14 cm. 750 to 480 extrapolated years b.p.

6.65 The lull in clearance activity , which is a feature of the preceeding Zone G - 4 , continues in Zone G - 5 , up to the 18 cm horizon , 617 extrapolated years b.p. At the 18 cm horizon extensive clearance is recorded mainly for pastoral agriculture .

This is indicated by the presence of Plantago lanceolata . Cereal pollen grains , which indicate cultivation , occur both at the 18 cm and 14 cm horizons . Ruderals , in particular , Taraxacum type , Compositae , Chenopodiaceae and Saxifragaceae are recorded . These are indicators of disturbances to the flora* . They are slightly more prevalent on the 18 cm horizon than on the 14 cm horizon .

Gramineae and Ericaceae both show marked increases at the 18 cm. horizon , but , start to decline at the 14 cm horizon . These new clearances which started in the mid 14th to the early 16th centuries , indicate a substantially enlarged population .

The fertile mouth of the Llanbedr valley was the location of arable and pastoral clearances . Earlier woodland regenerations on the lower mountain tops were cleared again to provide additional grazing lands . Despite the prolonged and extensive clearances recorded on this profile , Fraxinus has merely background T.A.P. percentages . This is a feature that is shared with the Waun Fach North profile and discussed in section 7.1 .

* See appendix , Table 6.2 .

FIG. 6.61

Pollen Diagram from "Pen Y Gader–Fawr", Black Mountains

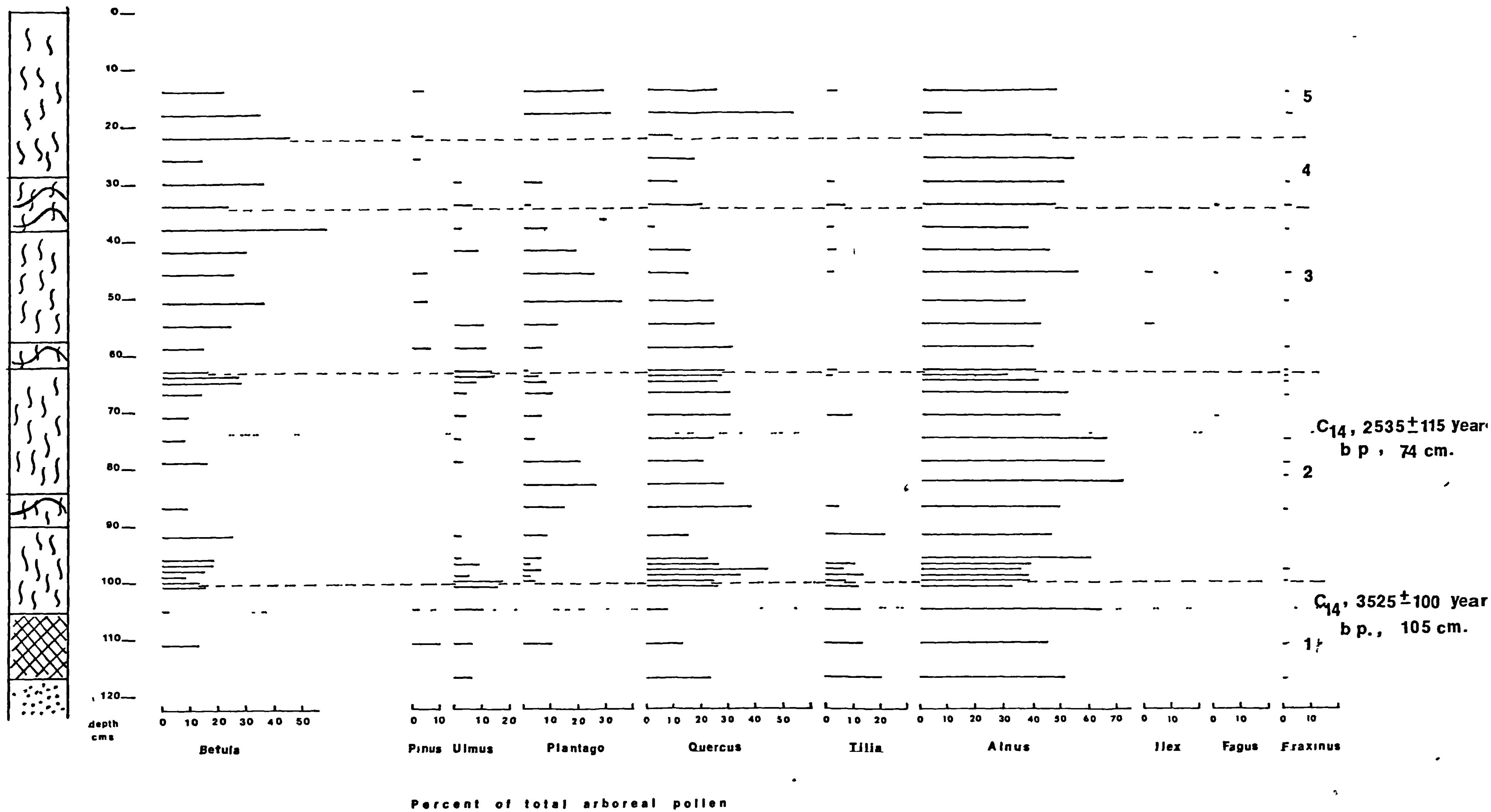


FIG. 6 62

Pollen Diagram from "Pen y Gader-Fawr", Black Mountains

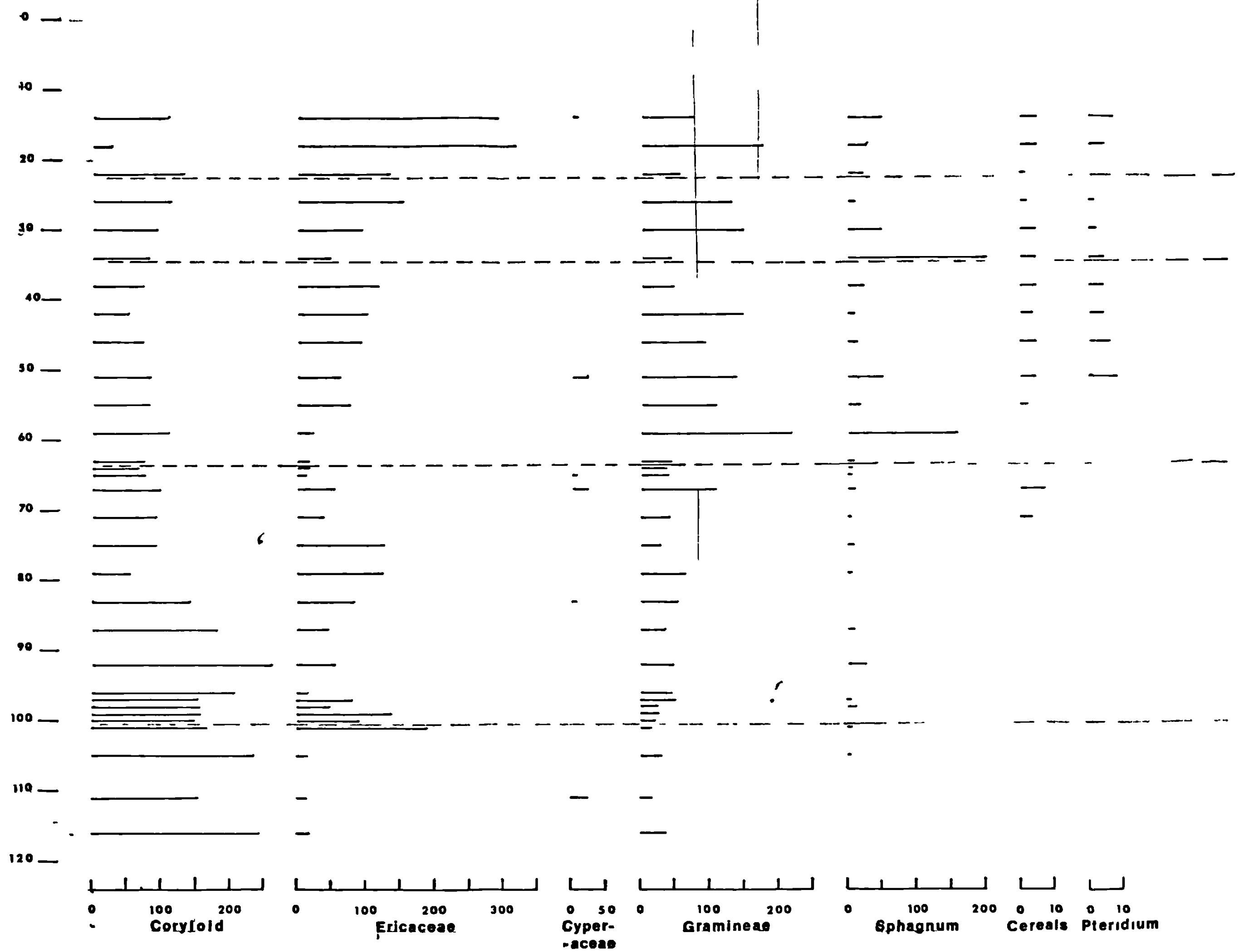


FIG 6 63

Pollen Diagram from PEN Y GADER-FAWR, Black Mountains

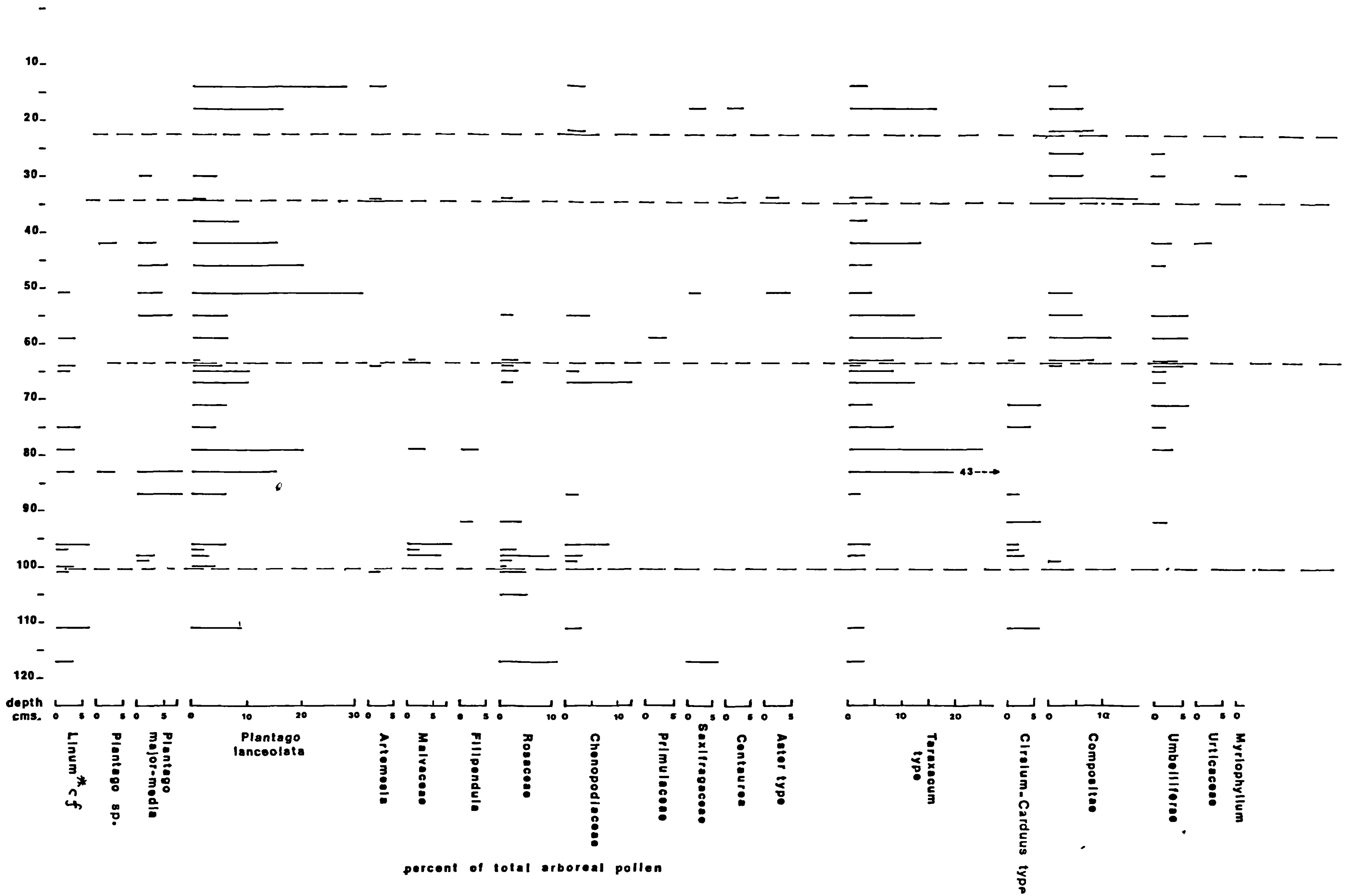
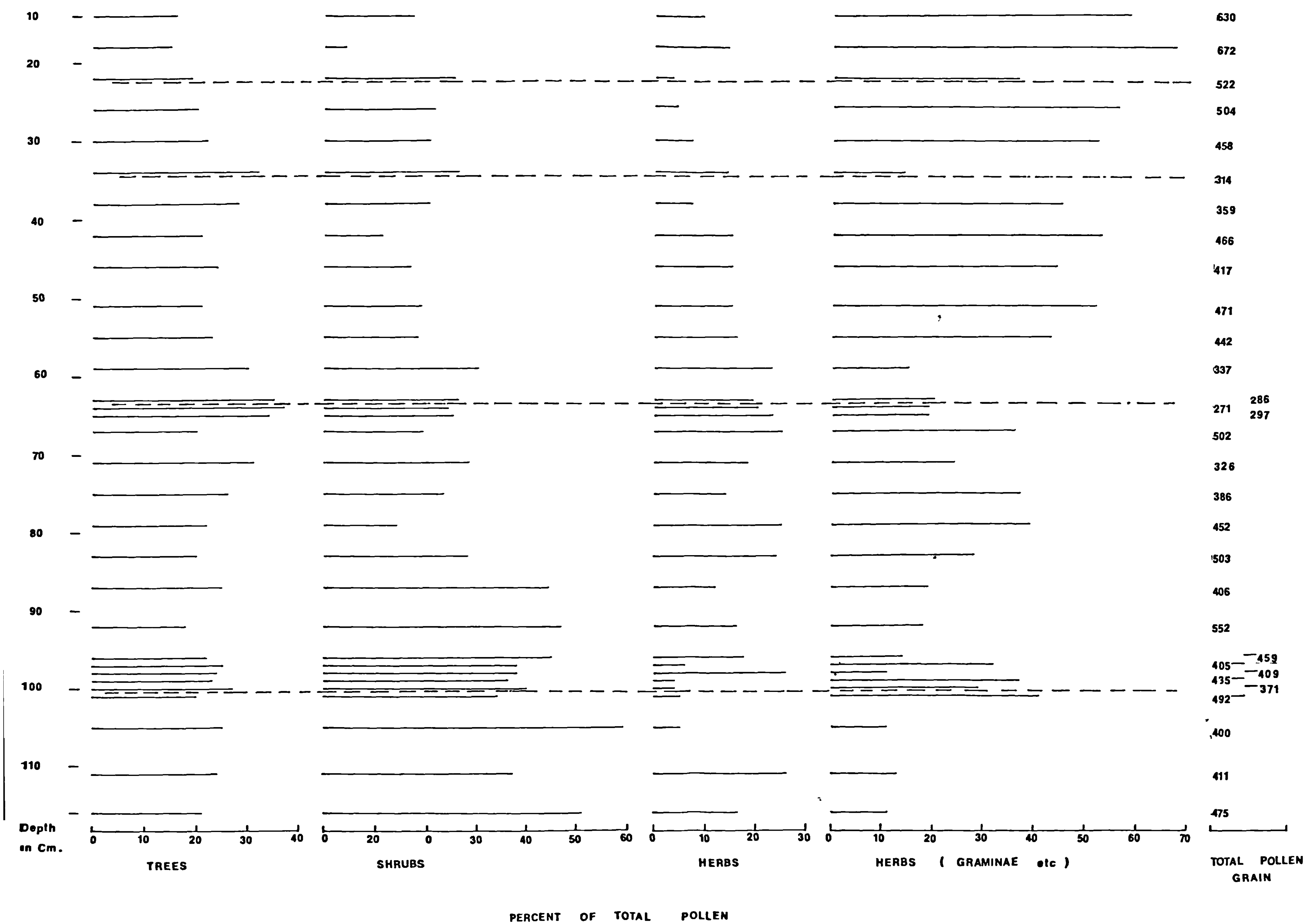


FIG 6.64

POLLEN DIAGRAM FROM PEN Y GADER FAWER BLACK MOUNTAINS



DISCUSSION ON THE WAUN FACH CENTRAL PROFILE , WAUN FACH SUMMIT , BLACK MOUNTAINS

.7 The profile is zoned as follows :

Section	Zone	Peat depth in cm.	Extrapolated years b.p.
6.79	C - 10	5 to 20	100 to 360
6.78	C - 9	20 to 45	360 to 650
6.77	C - 8	45 to 60	650 to 1150
6.76	C - 7	60 to 75	1150 to 1500
6.75a	C - 6b	75 to 134	1500 to 2130
6.75	C - 6a	135 to 150	2130 to 2370
6.74a	C - 5b	150 to 174	2370 to 2550
6.74	C - 5a	174 to 194	2550 to 3050
6.73	C - 4	194 to 219	3050 to 3600
6.72b	C - 3	219 to 225	3650 to 4150
6.72a	C - 2	226 to 231	4150 to 4450
6.71c	C - 1c	232 to 234	4500 to 4575
6.71b	C - 1b	235 to 242	4620 to 4900
6.71a	C - 1a	243 to 244	4950 to 5000

Note : All dates on this profile are taken by comparing the zone similarities with the radio-carbon dated profile on Waun Fach South .

See Figures 6.71 to 6.74 .

Plate 6.1

Aerial photograph of Waun Fach summit from the south showing profile of summit in background and the Gader ridge in foreground .

ZONE C - 1a

244 to 243 cm . 5000 to 4950 extrapolated years b.p.

6.71a Ulmus and Tilia decline from 14 % and 6 % to 6 % and 1 % T.A.P. respectively in the space of just one centimeter (244 to 243 cm .) . This coincides with the appearance of Plantago lanceolata with Filipendula sp. , Taraxacum type and Umbelliferae .

This suggests a severe clearance phase in which Tilia and Ulmus are selectively cleared . The appearance of Taraxacum type , Umbelliferae and Filipendula sp. suggest the exposure of open ground and reinforces evidence for clearance* . The selective removal of these two tree genera has been discussed by Smith. A.G. (1979) , in connection with leaf fodder , and bark stripping . This would have been chiefly used in winter time when grazing areas were limited .

The Ulmus clearance in Zone C - 1a , together with the later Ulmus clearances in Zone C - 1b , occur at a period of time corresponding to the time of the well - publicised " Ulmus decline " , which commenced around 5000 years b.p. and which was discovered in other pollen profiles in north-west Europe, Godwin. H. (1940), Tallis. J.H. (1964), and Pennington. W. (1965) .

Local pollen components such as Ericaceae and Gramineae show marked increases between the 244 and 243 cm horizons . The location of these selective clearances are mainly in the rolling Wye lowlands . The areas believed to be represented on this profile are shown in Figure 6.110. Some ruderals in this Zone (C - 1a) and in Zone C - 1b could well be local , from the Waun Fach plateau . This is discussed in section 7.4 .

* See appendix , Table 6.2 .

ZONE C - 1b

242 to 235 cm 4900 to 4620 extrapolated years b.p.

.71b This zone represents a comprehensive clearance phase in which both the magnitude and duration of clearance activity is unique to the Black Mountains profiles .

Quercus and Alnus are the first genera to be cleared . This is followed by the clearance of Tilia and later Ulmus . Betula increases substantially in this zone , indicative of a disturbance in woodland composition which enables the light demanding genus to germinate and flourish .

The size of the increase is probably magnified because of relative declines in the above - mentioned tree genera . The corresponding dramatic fall in Coryloid pollen , illustrates further, the severity of clearance of understorey as well as of upper canopy components .

Plantago lanceolata , Plantago major-media, Taraxacum type , and Filipendula sp. are represented during this period , denoting clearances leading to both pastoral and arable agriculture, Turner. J.(1965),and Moore. P.D.(1975) .

The uniqueness of this intensive clearance period in the Waun Fach Centre profile contributes to the idea that the Waun Fach profiles represent separate geographic areas . However , there are some portions of the Waun Fach South and Waun Fach Centre profiles which show similarities . This is taken to represent overlap areas which are shared between profiles .

Section 6.110, discusses the probable areas represented on all five profiles . From this discussion it is concluded that an area to the north - west of Waun Fach summit is most likely to be represented on the Waun Fach Central profile , that is slightly more northerly than Waun Fach South .

It is interesting to note the unusual nature of the clearance . Firstly ; Quercus and Alnus are cleared with the understory shrub Corylus ; later

Quercus and *Tilia* are selectively cleared ; and later still all four genera , as well as *Corylus* , are cleared .

This suggests that a damp *Quercus* / *Alnus* woodland was cleared first , and then trees on well - drained relatively rich soil were cleared . *Ulmus* and *Tilia* together with *Corylus* were the genera cleared from the richer soils . At the peak of clearance activity both areas were cleared simultaneously .

The use of fire in lowland areas represented on the Waun Fach Central profile could account for some of the clearances recorded . This is discussed in section 7.4 together with archeological evidence from the area .

ZONE C - 1c

232 to 234 cm 4500 to 4575 extrapolated years b.p.

6.71c This zone records another clearance phase which peaks at the 233 cm horizon. *Ulmus* is selectively cleared and drops from 9 % to 5 % T.A.P. There is a corresponding increase in *Plantago lanceolata* from 1 % to 3 % T.A.P. at the 233 cm horizon. Throughout this zone there is a continuous appearance of Chenopodiaceae.

Although these clearances come after the clearances recorded in the two basal zones C - 1a, and, C - 1b, the decline in *Ulmus* could be considered to be a continuation of the general decline and collectively could be called " the *Ulmus* decline ", see section 6.100.

Clearance activity declines at the 232 cm horizon and this coincides with *Ulmus* regeneration. The closing of the woodland canopy as a result of the *Ulmus* regeneration caused a reduction in *Corylus* pollen to 6 % T.P. at the 232 cm horizon, (see Figures 6.72 & 6.74).

ZONE C - 2

226 to 231 cm , 4150 to 4450 extrapolated years b.p.

6.72a This period on Waun Fach Central is notable for the absence of *Plantago lanceolata* (except at the 226 cm horizon) , and only the occasional presence of other ruderals .

Total arboreal pollen values are comparatively stable in this zone . One surprising feature of this zone is the frequent , total absence of *Ulmus* (230 to 227 cm ,) . Over the same period there is a steady increase in *Tilia* .

This could well represent a period when *Ulmus* branches and leaves are being cut for winter fodder on a large scale . The removal of *Ulmus* branches would stop flowering and subsequent pollen dispersal . This practice is still in use today in the Caucasus for winter fodder , Pennington . W . (1969) .

Following the resumption of flowering , *Ulmus* reappears at 228 cm , to 227 cm followed by another pruning, at 226 cm horizon, of *Ulmus* and this time, *Tilia* as well . However , some opening of the woodland canopy does occur with an increase in *Fraxinus* and *Corylus* T.A.P. The relevance of this absence of clearance activity is discussed with other Waun Fach profiles in chapter 7.4 , period D .

ZONE C - 3

219 to 225 cm. 3650 to 4150 extrapolated years b.p.

6.72b This portion of the profile shows a marked clearance of *Ulmus* / *Quercus* and *Corylus* . *Quercus* T.A.P. falls to nearly half and *Ulmus* is cleared almost to apparent extinction . There is a sharp rise in *Plantago lanceolata* at the 219 cm horizon .

This clearance phase at the 219 cm horizon is probably more extensive than that in Zone C - 1b . The date of this clearance phase is about 3641 extrapolated years b.p. and represents a new population increase . This date , 3650 extrapolated years b.p. , lies within the Bronze age period and is the first clearance since Neolithic times, circa 4500 extrapolated years b.p. The significance of this period of human activity is discussed in section 7.4 .

Fraxinus increases substantially at 219 cm giving a further indication of an opening up of the woodland canopy . The expansion of Gramineae , Ericaceae and *Pteridium* at the 219 cm horizon probably took place to the north-west of Waun Fach summit on the sloping uplands .

Clearances were primarily pastoral as is indicated by the presence of *Plantago lanceolata* . Some of these cleareances probably took place in lowland areas (see Figure 7.52) .

ZONE C - 4

219 to 194 cm 3650 to 3050 extrapolated years b.p.

73 This zone , which lasts about 600 years , contains three periods :

1 - A period of decreasing clearance between the 219 and 209 cm horizons .

2 - A period of clearance from the 209 cm to the 204 cm horizons .

3 - A further period of decreasing clearance in the 204 cm to the 194 cm horizon s .

During the first period of decreasing clearance , *Ulmus* and later *Quercus* and *Corylus* regenerate substantially . Clearances are resumed and increase to a peak at the 204 cm horizon . *Ulmus* fades out completely and *Quercus* and *Corylus* decrease appreciably .

However , with the opening of the woodland canopy, *Corylus* expands . With clearances, there are increases in *Plantago lanceolata* , *Plantago major - media* , *Artemisia* , Chenopodiaceae and Umbelliferae . The majority of clea - rances are pastoral rather than arable because the *Plantago lanceolata* T.A.P. is greater than that of *Plantago major - media** .

As clearance activity decreases towards the 194 cm horizon , *Fraxinus* and , to a lesser extent , *Ulmus* regenerate with a T.T.P. peak of 48 % of T.P. and a net increase of 7 % from the start of the zone .

* See appendix , Table 6.2 .

ZONE C - 5a

194 to 174 cm . 3050 to 2550 extrapolated years b.p.

4 The tree pollen peak at the 194 cm. horizon, with a T.A.P. percentage of 48 %, is marked by a small peak in Ulmus with rapidly declining Gramineae levels . Gramineae continues to decline to a joint Sphagnum Gramineae and Ericaceae low at the 190 cm horizon .

Shrub total pollen levels rise after 194 cm horizon to a peak of 49 % of T.P. at 190 cm horizon , an increase of 26 % of T.P. since the 194 cm horizon . This would represent an increase in the understorey Corylus component as well as in marginal scrub .

Betula levels rise slightly in the mid - zone which is a further indication of an opening up of the forest canopy . Quercus levels rise with the Plantago peak, indicating a relative increase because of other arboreal lows . The Plantago lanceolata peaks indicate a clearance for pastoral purposes which is of a shorter duration than the previous Plantago peaks , which were indicative of clearances for both arable and pastoral purposes . The intensity of clearance however , was less in this upper zone judging by the relatively strong Ulmus percentages of T.A.P.

By the end of the zone there is a net decline in Alnus , with a levelling off with Plantago lanceolata . At the 174 cm horizon , Ulmus has had a significant regeneration from 2 % to 4 % of T.A.P. Fraxinus reappears in the mid - zone as a result of the clearances .

The close of the zone shows increased Fraxinus percentages of T.A.P. following in a successional sequence after Betula . The unusually low levels of Gramineae , Ericaceae and Sphagnum at the 190 cm horizon are not recorded on the Waun Fach South and North profiles . These low levels are thought to represent an area of uplands to the north-west of Waun Fach summit , see section 6.110 .

ZONE C - 5b

174 to 150 cm 2550 to 2370 extrapolated years b.p.

.74a This zone starts off with a decline in Ulmus corresponding to rising Plantago lanceolata levels . The zone is highlighted by a great increase in the Plantago lanceolata levels at the 158 cm horizon accompanied by the Gramineae high which peaked at 168 cm

The Plantago peak is also accompanied by ruderals , indicators of arable agriculture, such as Umbelliferae , Chenopodiaceae and Taraxacum type pollen grains . Once again Corylus shows an initial expansion before the Plantago peak . Corylus is then cleared with Ulmus and Quercus at the 158 cm horizon . At shallower horizons Corylus percentages of T.A.P. decrease with the increasing canopy cover of Ulmus and Tilia . A sharp decrease in Betula corresponds to an increase in Corylus (4 % of T.P.) , which indicates that Betula is being cleared .

The subsequent increase in Betula and Fraxinus is due to a regeneration of fresh , dense tree canopies being actively thinned . Towards the end of the zone the Betula rise slows down as Ulmus regeneration increases and the canopy does not allow enough light for the germination of Betula seedlings Moore . P.D. and Bellamy . D.J. (1974) .

The corresponding Fraxinus peak indicates a successional sequence following Betula . The low Alnus level at the 166 cm horizon corresponds to a Gramineae peak which probably indicates a clearing of Alnus woods in the wetter low lying areas ; these clearances could be in preparation for sheep and cattle grazing .

To summarise , in Zone C - 5b we have the highest Plantago lanceolata peak (at the 158 cm horizon) , recorded to date . This implies a

6.74a

substantial increase in population, probably as a result of influxes from outside the area. Judging by the date of the profile, which is approximately 2400 years b.p. (extrapolated), it is conceivable that the influx represented the first wave of Iron age peoples (see section 7.2 & 7.3).

ZONE C - 6a

150 to 135 cm 2370 to 2130 extrapolated years b.p.

6.75 In this portion of the pollen profile , Ulmus , initially declines slowly with Plantago lanceolata climbing equally slowly and with Gramineae levels remaining fairly consistant .

This is followed by a sharp decline in Ulmus and a corresponding sharp rise in Plantago lanceolata . Betula increases steadily throughout the zone , leveling off at the 135 cm horizon . This indicates continuous clearance activity and an opening up of the woodland canopy .

This is also demonstrated by a marked increase in Corylus pollen to 42 % of T.P. Corylus then declines rapidly partly as a result of over - shadowing by Betula and Alnus .

The intensification of the clearance phase in the upper portion of this zone is supported by the reappearance of Taraxacum type and Chenopodiaceae pollen indicating arable agriculture, Walker M.F. & Taylor J.A. (1976) .

The rather overshadowing Plantago lanceolata % of T.A.P. at 135 cm together with Gramineae levels doubling at 140 cm indicate that these clearances were primarily for pastoral agriculture . T.A.P. % 's of Fraxinus pollen decrease during this clearance phase but , after sharp Betula increases in the previous zone showing the successional nature of the genus .

Further up the profile the apparent Fraxinus decline is at first misleading but perhaps is the result of an over - representation of pollen by Betula and Alnus . The total tree pollen levels at the 135 cm are 40 % T.P. which is 9 % T.P. below the starting level . This indicates a real depression in tree numbers and confirms the evidence of clearances as indicated by the increase in Plantago lanceolata .

6.75a To summarize , Zone C - 6a , shows increasing clearance activity - from the 140 cm horizon onwards and is followed in Zone C - 6b by the most extensive clearance period in the whole profile . Zone C - 6a represent therefore a gradual build up in population , probably resulting from a new wave of people entering the Black Mountains area, Savory H.N.(1976) .

Clearances in Zone C - 6a are mainly for pastoral agriculture . The location of these clearances is mainly in lowland areas but even extend up into high uplands to the north-west of the Waun Fach summit . This conclusion is more plausible when one considers the clearance by fire which preceeded peat initiation above an altitude of 600 metres at the Ty isaf profile site , west of the Waun Fach summit . The greater utilization of upland areas is even more apparent in the following zone (Zone C - 6b) , which is described in the next section (6.76) .

ZONE C - 6b

134 to 75 cm 2100 to 1500 extrapolated years b.p.

6.75a This zone represents the longest duration of woodland clearance in the profile . Gramineae levels rise steadily to the first peak at 125 cm then climb very sharply at 115 cm . to over 80 % of T.A.P. , the highest for the whole profile . Gramineae then drops sharply to a low at 105 cm. , and followed by the formation of a broad low peak before declining at 85 cm horizon. Pteridium spreading after clearance, is very prominent in this zone .

Plantago lanceolata continues to rise with its first peak at the 130 cm horizon then to a much higher peak at 110 cm. It then drops sharply at 105 cm and then rises to another high peak at the 100 cm horizon . Finally Plantago lanceolata declines steadily to 85 cm (and beyond) .

The record of these two genera alone , when compared to the sharp fall in total arboreal pollen from 40 % to 21 % T.P. (a decline which extends down to the 110 cm horizon) , indicate a woodland clearance extending over a long period of time . The increase in total arboreal pollen after the 110 cm horizon is indicative of a reduction in woodland clearance .

Plantago major-media also reappears in this profile and peaks at 120 cm This reappearance , together with the presence of Taraxacum type , Artemisia , Chenopodiaceae , and cereals is indicative of arable agriculture*. The overwhelming emphasis is however, pastoral agriculture .

In the initial part of of this zone Betula stops increasing and starts a decline with a low at 115 cm. This is paralleled by a series of Fraxinus peaks during the maximum period of clearance activity followed by a recovery of Betula and a very substantial increase in Fraxinus .

* See appendix , Table 6.2 .

Corylus T.A.P. decline sharply to a low at 115 cms. with 11 % of T.P. a drop of 17 % T.P. from 135 cm and a drop of 31 % T.P. from 145 cm to 115 cm

The severity of the decline in *Corylus* is indicative of the extent of clearance . It is only after the main clearance that *Corylus* regenerates , perhaps on marginal woodlands . *Tilia* makes two reappearances but these represent minor regenerations in certain pockets of the woodland that are temporarily , not cleared .

Ulmus regenerates at the same two locations as *Tilia* , then regenerates again at the top of the zones as clearance activity subsides . The multiple peaks of *Quercus* are not indicative of regeneration during the clearance because of the overall decreases in total arboreal pollen . They are merely increases due to decreases in other genera . *Pinus* reappears towards the upper portion of the zone indicative of the dry woodland regeneration .

It should be mentioned that the first total pollen peak occurs at 95 cm which has 33 % of total pollen compared to 40 % T.P. at the start of this zone . The middle arboreal pollen peak occurs at the 85 cm horizon with 43 % T.A.P. The main arboreal increases during this 85 cm. peak are from *Betula* and *Fraxinus* .

The third total arboreal pollen peak is at 75 cm with 57 % T.P. , an increase of 17 % from 135 cm horizon . *Betula* and *Fraxinus* and , to a lesser extent , *Quercus* , make the percentage gain indicating still a fairly open woodland community . With this information it can be seen that the regenerated woodlands are more open at the start of the zone .

The 75 cm horizon marks one of the steepest drops in Gramineae , *Plantago lanceolata* , Ericaceae and other herbs and ruderals . *Betula* levels peak ,Alnus has a distinct dip in its curve . This marks the close of this extensive clearance phase which started at the 138 cm horizon .

To conclude on an historical note , Zone C - 6b which extends over a period of more than 600 years , from 2100 to 1500 years b.p. (extrapolated) , encompasses portions of the Iron age , the whole of the Roman occupation , and extends into the post - Roman period of inter - tribal conflicts .

In this zone more emphasis is given to arable agriculture with cereal pollen and Plantago major - media appearing at several horizons . The extent of clearances suggests a very large increase in population which was maintained for several centuries . Clearances were not only for agriculture but for extensive fortification(Figure 7.2), road building , Davies D.J. (1933) , and wood cut for construction and even for export , Thomas . D . (1977) .

A new t echnology using iron and new knowledge was introduced into the area by the Silures, Thomas. D. (1977), and even more so by the Romans,Davies D.J. , (1933) . The application of this new knowledge gave " land use " a new meaning .

The accumulated effect of the long period of human activity on the vegetation of the Black Mountains area was to open up the lowland woodlands and to increase considerably the lowland and upland grazing areas .

Eventually , the removal of the remaining tree cover from the upland areas to provide additional grazing lands , had more lasting effects . The repeated removal of trees exposed the underlying soil to a continuous leaching out of soil nutrients .

This made subsequent arboreal regeneration impossible , and , in some areas , paved the way for peat initiation . The rich lowlands were not leached , so that arboreal regeneration and succession could continue in man's absence .

ZONE C - 7

75 to 60 cm 1500 to 1150 extrapolated years b.p.

6.76 This zone represents a short clearance period followed by a partial woodland regeneration . Gramineae percentages remain at a very low level (below 10 % T.A.P. , in relation to the rest of the profile) , throughout the zone . Ericaceae is very stable maintaining approximately 40 % T.A.P. compared to 260 % T.A.P. at the height of the previous phase .

Plantago lanceolata is again registered in a small peak at the 65 cm horizon together with Plantago major - media and Chenopodiaceae which is also recorded at this peak . This clearance peak is indicative of arable and some pastoral agriculture . This coincides with a sharp fall in arboreal pollen to 30 % T.P. (from 57 % T.P. at 75 cm.) .

Corylus pollen increases substantially during this initial clearance and rises to a peak of 59 % T.P. at 65 cm , indicating a significant opening up of the woodland canopy and also marginal shrub expansion . Plantago levels fall again and are not recorded at the arboreal regeneration peak at 60 cm , which reduces levels of Coryloid pollen (the overshadowing effect) .

The overall herb pattern is one of a small increase with ruderals remaining at 2 % T.P. The only species which increases at the upper horizon is Quercus with 50 % T.P. The woodland composition has changed to a more complete canopy with the reduction of the light demanding genera , Betula and Fraxinus . The decline in Alnus is real as a consequence of Quercus regeneration . Ulmus experiences a mid-zone peak together with Pinus at the 70 cm. horizon as a result of reduced clearance activity in certain previously cleared areas .

To conclude , the partial woodland generation , which follows the initial short clearance period , suggests that there is a reduction in population . The historical implications of the palynological data from the Black Mountains are discussed in section 7.2 .

It should be noted that most of the clearances occuring in Zone C - 7 are for arable agriculture and are concentrated in lowland area where soil fertility is greater and weather is milder .

ZONE C - 8

60 to 45 cm . 1150 to 650 extrapolated years b.p.

6.77 A sharp decrease in total arboreal pollen occurs at the 55 cm. and 50 cm. horizons mainly as a result of Quercus woodland clearance followed by a partial regeneration at 45 cm . to 38 % of T.P. (a drop of 5 % T.P. overall) .

The removal of Quercus allows , first Betula and then Fraxinus (from 50 cm onwards) ,to flourish . Coryloid values drop sharply at 55 cm but afterwards recover and stabilise . This may be due to regional variations as a result of Ulmus regeneration and to a closing of the tree canopy .

Plantago lanceolata makes steady gains as a result of clearance for grazing . There are also records of Artemisia , Centaurea sp. and Chenopodiaceae . Ericaceae and Gramineae also increase steadily and follow a similar upward curve to Plantago lanceolata , thus indicating that the clearance is pre - dominantly for pastoral purpose* .

It is difficult to determine the tree line on the Black Mountains at this time . Probably all of the areas on the mountain plateaux were covered with Ericaceae plants and with Gramineae . Most , if not all of the north - western slopes would probably be open woodland or grasslands up to the 350 m contour (see Figure 6.110) .

The lowlands around the Wye river to the north - west were probably used extensively for cattle while in the narrow upland valleys there were , pre - dominantly , sheep . This is the modern trend which probably has not changed much from the time period under discussion (see sections 3.17 to 3.19 on land use) .

Ulmus regenerates steadily from the 60 cm horizon upwards . At the same time there is a corresponding depletion of Plantago lanceolata . The high

* See appendix , Table 6.2 .

proportion of Fraxinus indicates appreciable areas of open woodland .

Zone C - 8 , with its increase in pastoral and to a lesser extent , arable agriculture (cereal pollen grains present) , corresponds in time with an historically important period in Welsh history , namely the Norman period (see section 7.1 period A) .

The lowland areas become increasingly open with increasing Fraxinus . In addition there is an increased proportion of ruderals which indicate disturbances to the flora

ZONE C - 9

45 to 20 cm. 650 to 360 extrapolated years b.p.

6.78 Total arboreal pollen decreases to a low at 35 cm *Ulmus* is not selectively cleared but actually peaks at this horizon with the reappearance of *Tilia* . *Fraxinus* is not recorded and *Betula* levels are depressed , indicating severe woodland clearance . This also corresponds to a *Plantago lanceolata* peak which is as great as the *Plantago lanceolata* peak between 135 and 100 cm , and is indicative of extensive woodland clearance .

Gramineae also peaks at the 35 cm horizon , giving further evidence of clearances for pastoral agriculture . This situation with *Ulmus* and *Plantago lanceolata* peaking together has been shown to exist in other Black Mountains pollen profiles (W.F.S. ,(125 cm),Ty isaf (35cm).This occurs when clearance activities move to new areas , leaving perhaps less convenient areas to undergo a natural arboreal regeneration .

This may well have been the case on lower hillsides of the Black Mountains north-west of the Waun Fach summit lowlands (see Fig. 6.110) . The significant increase in pastoral activity at the 35 cm horizon is a response to a growing demand for produce , namely meat and wool .

At this 35 cm horizon , *Betula* and *Alnus* were cleared in open woodlands and along the many stream banks in the Wye lowlands . However , from 35 to 20 cm *Ulmus* and *Betula* were cleared to provide more grazing areas . The more damp areas were allowed to regenerate as *Quercus* / *Alnus* woodlands . The fluctuations in clearances were less and less dependent on local requirements , but were influenced more and more by trade (see section 7.1) .

ZONE C - 10

20 to 5 cm. 360 to 100 extrapolated years b.p.

6.79 The profile starts with Ericaceae increasing steadily , as the peat depth decreases . Gramineae also increases steadily with a slight drop at the 5 cm. horizon . *Plantago lanceolata* increases with ruderals especially *Taraxacum* type, Umbelliferaeae and *Pteridium* spores with decreasing depth indicative of an opening up of the woodland and a predominance of pastoral , and some arable agriculture .

Cereals actually decline slightly and , *Betula* and , to a lesser extent , *Fraxinus* increase . *Betula* rises sharply with *Plantago lanceolata* at the 5 cm horizon . This is accompanied by a depression in *Alnus* and *Quercus* . *Ulmus* declines at 20 cm and then regenerates at the 5 cm horizon .

The overall impression , apart from a lull at 15 cm , is one of increasing clearance . The lowland woodland canopy is becoming more open as indicated by increases in *Betula* and *Fraxinus* . T.A.P. values . Ruderals, indicators of both pastoral land and of exposed soil , increase appreciably towards the 5 cm horizon . Population levels at this time are known to have been steadily increasing throughout Wales , Thomas . D . (1977) .

The Napoleonic wars stopped grain imports and thus intensified the need for home agricultural production . Marginal areas were brought into production and grazing areas were pushed higher up the hillsides . In this zone (C - 10) , the emphasis was still on pastoral agriculture . In section 7.1 , there is a description of land use on all five Black Mountains profiles .

FIG 6 71 Pollen Diagram from WAUN FÂCH Central, Black Mounains

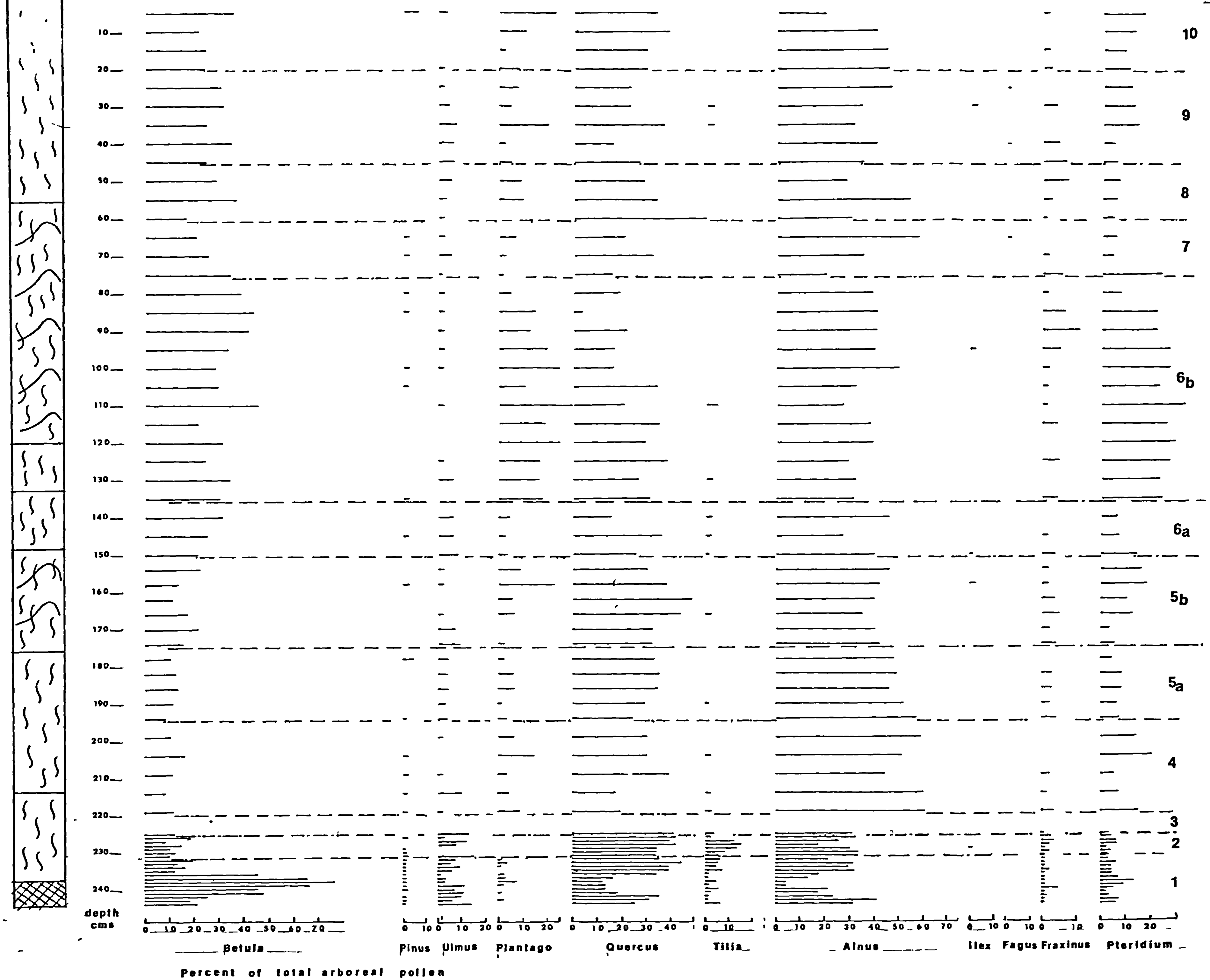


FIG. 6.72

Pollen Diagram from WAUN FÂCH Central, Black Mountains

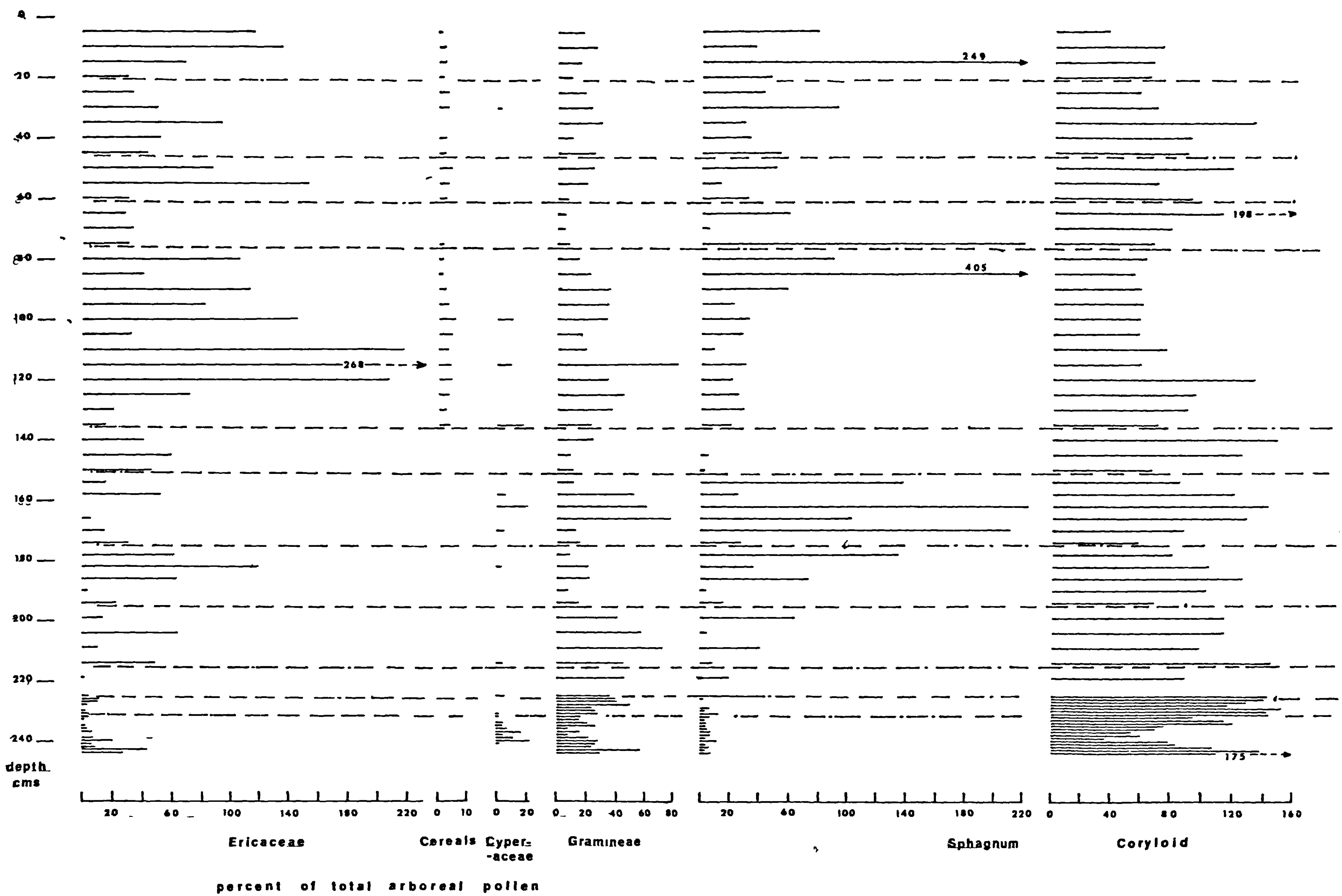


FIG 6 73

Pollen Diagram from "Waun Fach' Central Black Mountains

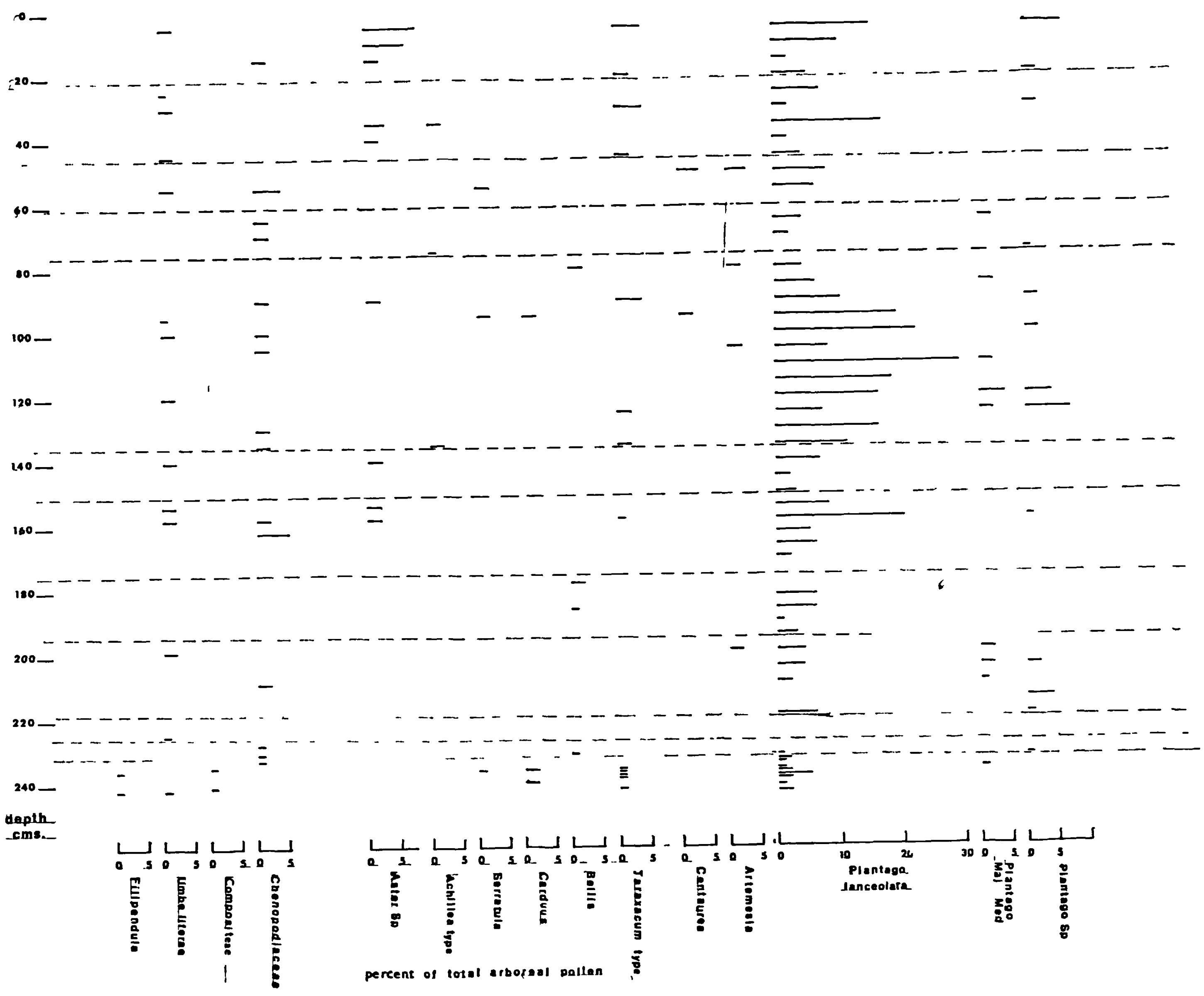
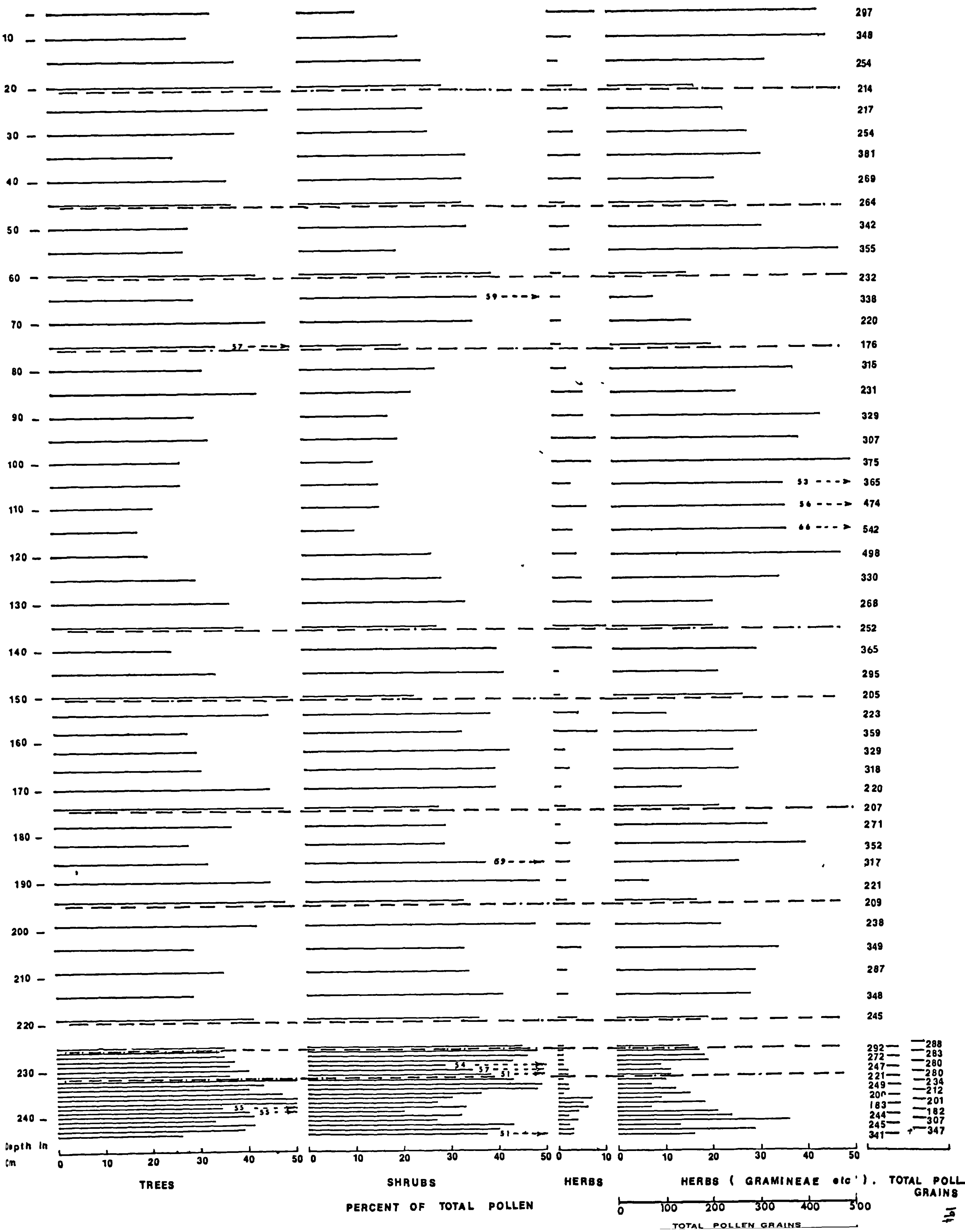


FIG. 6.74

POLLEN DIAGRAM FROM WAUN FACH CENTRAL, BLACK MOUNTAINS



DISCUSSION OF THE WAUN FACH SOUTH POLLEN PROFILE ON THE WAUN SUMMIT , BLACK MOUNTAINS

6.8 The profile has been divided into a number of Zones , S - 1 to S - 10 as follows : -

Section	Zone	Peat depth in cm	Extrapolated years b.p.
6.89	S - 10	6 to 22	100 to 360
6.88	S - 9	22 to 40	360 to 650
6.87	S - 8	40 to 70	650 to 1150
6.86	S - 7	70 to 90	1150 to 1500
6.85a	S - 6b	90 to 140	1500 to 2130
6.85	S - 6a	140 to 159	2130 to 2370
6.84a	S - 5b	159 to 173	2370 to 2550
6.84	S - 5a	173 to 201	2550 to 3050
6.83	S - 4	201 to 214	3050 to 3600
6.82	S - 3	215 to 227	3650 to 4150
6.81a	S - 2	227 to 234	4150 to 4450
6.81	S - 1	235 to 250	4500 to 5100

See Figures 6.81 and 6.84 .

DISCUSSION ON EACH ZONE OF THE WAUN FACH SOUTH POLLEN PROFILE

ZONE S - 1

Base to 235 cm , 5100 to 4500 years b.p.

6.81 A radio-carbon date , obtained 7 cms. from the base of the profile is 4830 ± 55 years b.p. This gives an extrapolated date for peat initiation of 5100 extrapolated years b.p. (extrapolated C_{14}) , which is within the limits of the Neolithic Ulmus decline .

The first zone extends from the base to 235 cm (see Fig. 6.81), which represents a total tree pollen peak and a stratigraphic transition between a lower very dark brown and an upper lighter brown zone. Ulmus levels have fluctuated but with a gentle downward trend after the 242 cm horizon. Tilia follows an opposite trend rising when Ulmus dips and falling when Ulmus rises. This is probably indicative of small selective clearances of Ulmus. Quercus rises throughout the zone with small peaks and troughs. Betula follows a similar trend to Ulmus. Pinus with levels generally below 5% T.A.P. shows erratic fluctuations and periods when it is not recorded. Plantago major-media appears first at 236 cm and peak at 234 cm Corylus drops sharply at 238cm from over 260 % to 180 % T.A.P. at 240 cm Ericaceae and Gramineae levels are very erratic with a slight mid-zone peaked distribution. Ruderals increase slightly around the Plantago major-media peak.

This zone is indicative of slight clearance activity of Ulmus and marginal Corylus woodland. The presence of Plantago major-media as Ulmus begins to decline together with increasing ruderals particularly Chenopodiaceae and Carduus/Cirsium type and Artemisia does indicate human activity and suggests arable agriculture.*

* See appendix , Table 6.2 .

6.81 *Quercus* T.A.P. rise steadily throughout this area of the profile unaffected and possibly partially benefitting from the *Ulmus*, *Corylus* and *Pinus* fluctuations. The total tree pollen peaks at 234 cm , with over 30% T.P. from an initial 21% T.A.P. This substantiates a *Quercus* regeneration . *Alnus* is basically stable except for a rapid increase at 240 cm as a result of falls in *Quercus* and *Ulmus*. There is a tendency after 240 cm for *Alnus* to fall slightly indicating a slight clearance of *Alnus* from the mixed *Quercus*, *Alnus* , *Betula* and *Ulmus* forest , or from wetter areas in valley bottoms or along the edges of gulleys .

No classic *Ulmus* decline as described by Godwin , H . (1940) , circa 5000 years b.p. , is present on Waun Fach South . There is however , a later or second *Ulmus* decline at 4500 years b.p. (at 236 cm) and extending into Zone S - 2 to 231 cm This later *Ulmus* decline has been found by other researchers , Smith A.G. (1961-1962) , Merryfield D. & Moore P.D.(1974), see section 6.100.

The pastoral and arable clearances are located in lowland areas probably to the north - west of Waun Fach in the Wye lowlands . This deduction is made after comparison with other Black Mountain profiles (see Fig, 6.110). The presence of weed clearance indicators at the base of all three Waun Fach profiles is discussed in the correlation section 7.4.

ZONE S - 2

234 to 227 cm 4448 to 4150 extrapolated years b.p.

CLEARANCE PHASE

6.81a *Ulmus* continues to fall to a much greater degree, to a low at 231 cm This represents a decrease of 10 % T.A.P. (16 to 6 % T.A.P.), in a space of 4 centimetres or approximately 170 years.

Quercus T.A.P. continues to climb steadily ; *Tilia* actually peaks at the *Ulmus* low, whereas *Alnus* has dropped sharply from 40 to 30% T.A.P. in a thickness of 1 cm of peat. *Corylus* climbs very slightly at the *Ulmus* low and *Betula* doubles from 234-231 cm

At this point of maximum *Ulmus* decline the ruderals peak. *Plantago major-media* is present in the basal zone and continues to appear but is not recorded at the maximum *Ulmus* low. This whole sequence starting in the previous zone represents a forest clearance by humans of *Ulmus* and *Alnus*. The simultaneous expansion of ruderals peaking at the *Ulmus* low with a wide range of arable agricultural indicators, e.g. *Plantago major-media*, *Carduus/Cirsium* type, Chenopodiaceae, and a depression in total tree pollen levels substantiate this conclusion.

This dramatic *Ulmus* decline which starts in the previous Zone S - 1, corresponds to the *Ulmus* decline found in many sites in Britain and North Western Europe. The steady increase in *Quercus* and a fall in *Alnus* during this *Ulmus* decline is similar to that found at Plynlymon and Llyn Gynon diagrams, P.D. Moore (1966), but is the reverse of what occurs on Exmoor, D. Merryfield (1977), see section 6.100 .

6.81a

The increase in *Betula* at the *Ulmus* low is indicative of a more open woodland .

After the *Ulmus* low at 231 cm there follows a period of *Ulmus* regeneration together with a general increase in total tree pollen (T.A.P.) . Tree levels rise from 27 to 36% T.A.P. (231 to 227 cm horizons). *Quercus* continues to increase , as it has done since the beginning of the profile. *Ulmus* and *Alnus* also increase in this period. This results in a closing of the woodland canopy which is indicated by a fall in *Betula* which needs light for seedling germination and a fall in *Corylus* indicative of a closing canopy (by having a restricted pollen dispersal impeded by a closure of the canopy). Gramineae and ruderals also decline at the T.A.P. high. During this same period *Tilia* T.A.P. decrease probably as a result of competition.

Clearances are taken to be in similar locations to those in Zone S - 1 ; i.e. to the north - west of Waun Fach (see Fig , 6.110 , Waun Fach South area) , and quite possibly near the Pen y Wyrlod long cairn site .

ZONE S - 3

227 to 215 cm 4150 to 3650 extrapolated years b.p.

6.82 Ulmus continues its regeneration phase together with Alnus and rises to a peak at 223 cm , 4000 extrapolated years b.p. Pinus levels are unchanged. Quercus drops sharply with Betula levels rising. Corylus starts to climb and Gramineae and Ericaceae levels form a small peak at 223 cm Ruderals are up by 1% of T.P.

This portion of the profile represents an Ulmus regeneration phase which started after the Ulmus low at the 231 cm horizon .During the period,the woodland canopy, which is thought to be in the lowland areas and lower hillsides becomes marginally more open. This is indicated by Betula and Corylus T.A.P. increasing more Corylus pollen being lifted above and out of the canopy component . This is also substantiated by increase in the levels of Gramineae and ruderals which are growing in some of these cleared areas as well as near Waun Fach South. The partial opening up of the canopy represents a small selective clearance .

After the regenerated Ulmus high at the 223 cm. horizon (13 % T.A.P. , 3.8 % T.P.) there follows a progressive , and in some levels accelerated decline in Ulmus . Tilia , as before , initially benefits from the Ulmus decline , but as clearance intensifies Tilia also declines . Betula as a result of the continued opening of the forest canopy initially expands and then is replaced by Fraxinus in a successional sequence , Moore P.D. and Bellamy D.J. (1974) .

This is the first showing of Fraxinus on Waun Fach South , and represents a significant , but probably limited opening of the woodland canopy . Corylus continues to increase considerably . The increase in Corylus pollen indicates a progressive opening of the valley forest canopy , Moore P.D. and Bellamy D.J. (1974) .

6.82

Corylus pollen continues to increase until it reaches a peak at the 215 cm horizon . This represents an increase to 63 % T.P. from 46 % T.P. at the 227 cm horizon. The high *Corylus* T.P. is discussed in section 7.4 .

Zone S - 3. represents an interesting period in time because it lies between two , more intensive , clearances phases . One , below in Zone S - 2. (section 6.81a), and the other , above , in Zone S - 4. (section 6.83) . The historical significance of Zone S - 3. is discussed in chapter 7 , section 7.4 .

Clearances in Zone S - 3. are most probably confined to the rolling lowlands to the north - west of Waun Fach summit (see Figure 6.110) . The commencement of these clearances is dated approximately 3650 extrapolated years b.p. and probably represents the first Bronze age clearances in this profile . The larger and more extensive clearances at the 205 cm horizon probably occured in the late Bronze age , (see section 7.4) .

ZONE S - 4

201 to 214 cm . , 3050 to 3600 extrapolated years b.p.

83 A substantial selective clearance of *Ulmus* and *Quercus* is recorded on the 214 cm horizon , coinciding with the re-appearance of *Plantago lanceolata* which indicates pastoral clearances . Up to this horizon , this is the most severe decline in *Ulmus* . It occured in woodlands already depleted of *Ulmus* by earlier clearances in Zone S - 2 .

After a partial *Ulmus* regeneration at the 211 cm to 208 cm levels , *Ulmus* and *Tilia* are selectively cleared to apparent extinction . This occured at the 205 cm horizon about 3200 extrapolated years b.p.

At least three separate clearance episodes are recorded in this zone . All these clearances are within the Bronze age period . The earlier clearances probably represent early or middle Bronze age (214 cm and 211 cm 3600 and 3500 extrapolated years b.p.) . The larger , more extensive clearances at the 205 cm horizon probably occured in the late Bronze age . *Ulmus* and *Tilia* could well have been used for winter fodder as they were by the earlier Neolithic peoples , Pennington . W . (1969) .

The end of Zone S - 2, is marked by a cessation of clearance activity and a regeneration of *Ulmus* and *Quercus* . The woodlands in the Wye lowlands (as recorded in the Waun Fach South profiles) , became more dense . *Corylus* declined sharply as did *Betula* and *Fraxinus* . The rise in T.T.P. to 30 % at the 201 cm horizon confirms this regeneration period .

ZONE S - 5a

201 to 173 cm. 3050 to 2550 extrapolated years b.p.

6.84 This zone is marked by two phases ; (A) an initial clearance phase from the 201 cm horizon to the 189 cm horizon and (B) , a phase of regeneration from the 189 cm horizon to the 173 cm horizon .

A : Initial phase

201 cm to 189 cm 3050 to 2750 extrapolated years b.p.

Betula and *Corylus* increase steadily throughout this portion of the profile , which indicates a large-scale opening up of the woodland canopy . There is also a great , three-fold , increase in Gramineae which rises to a peak at the 189 cm horizon .

This Gramineae increase provides supporting evidence for the opening of the woodland canopy . Evidently , large areas were cleared for grazing in the rolling Wye lowlands and possibly on the foothills north -west of Waun Fach (see Figure 6.110) .

Plantago lanceolata and *Plantago major-media* , both rise to peaks at the 189 cm horizon , after a decline in *Ulmus* , indicating clearance for both pastoral and arable farming . In addition , Chenopodiaceae and *Artemisia* both indicators of clearance , are recorded as Gramineae and *Plantago sp.* T.A.P. are building up . *Alnus* T.A.P. fluctuate but do not show signs of decline where as *Quercus* T.A.P. do decline slightly .

To summarise , the evidence for woodland clearance is striking . There is the fall in T.A.P.. levels for *Ulmus* , *Quercus* , and *Pinus* ; a corresponding increase in ruderals and other herbs such as Gramineae , and the increase in *Plantago lanceolata* and *Plantago major-media* . The magnitude of the Gramineae peak at the 189 cm horizon indicates a more intensive clearance than previous ones ., and a sharp increase in grazing areas .

6.84 While the twin peaks of Plantago lanceolata and Plantago major-media at the same horizon of 189 cm point the dual purpose (pastoral and arable) of the clearances . The date , corresponding to this horizon of extensive clearance , is 2750 extrapolated years b.p. , which places it in the late Bronze age .

It is probable that some of these clearances were for the preparation of settlement sites , with areas for crop production and for large grazing herds . Ulmus leaves may have been used for fodder (see section 6 .100) , and Quercus may have been used for dwelling construction and possibly for firewood in the winter .

(B) : Regeneration phase .

189 to 173 cm , 2750 to 2550 extrapolated years b.p.

Plantago lanceolata , Plantago major-media , Gramineae , ruderals and Corylus all decline sharply after their peaks at 189 cm Even Betula initially declines but later climbs sharply and peaks at the total tree pollen peak at the 173 cm horizon . Ulmus regenerates and climbs to a peak at 177 cm before the main , total tree pollen peak at 173 cm Quercus T.A.P. initially rises then drop sharply at the Ulmus peak and regenerate at the tree pollen peak . Tilia after peaking at the maximum clearance peak at 189 cm declines and is not registered .

Pinus is not recorded at all during this portion of the zone . Alnus T.A.P. decrease somewhat erratically throughout this period . The steady Corylus pollen reduction is due mainly to a canopy closure restricting pollen dispersal . The continued , almost uninterrupted rise in Betula , indicates that woodland regeneration occurs but the woodland continues to be fairly open.

The *Betula* peak at 173 cm ., 35 % T.A.P. represents a 13 % T.A.P. increase from the 189 cm. horizon, indicates a further substantial expansion of *Betula* not only in the mixed forest but also probably in pure stands on untended uplands and hillsides north-west of Waun Fach South , (see Figure 6.110) .

The increase in total tree pollen , which peaks at the 173 cm horizon , makes up 41 % of total pollen . The peak includes 35 % T.A.P. for *Betula* ; 21 % T.A.P for *Quercus* ; 42 % T.A.P. for *Alnus* and 2 % T.A.P. for *Ulmus* .

In this zone (S - 5a) , it can be seen that although *Ulmus* regenerates it no longer attains it previous proportions in the woodland community . Thus , by a prolonged and intermittant removal of *Ulmus* the net trend is to be an ever - diminishing woodland component .

An opposite trend applies to *Betula* which flourishes with woodland disturbances . Thus with successive clearances , *Betula* responds to the continued opening of the woodland canopy , Moore P.D. and Bellamy D.J. (1974) .

ZONE S - 5b

173 to 159 cm. 2550 to 2350 extrapolated years b.p.

Phase A. 173 to 167 cm . 2600 to 2470 extrapolated years b.p.

6.84a Ulmus regenerates steadily and reaches a peak with Pinus .- Quercus levels increase but are slightly depressed at the Ulmus peak . Alnus is also increasing This regeneration coincides with a sharp fall in Betula and a sharp rise in Corylus . The Corylus regeneration occurs on the margins of the woodland .

Ericaceae , a local pollen component , spreads up the more upland and slope regions , north-west of Waun Fach South , to replace some earlier grasslands . This spread of Ericaceae is marked by a large Ericaceae peak at the 167 cm, horizon and is due to a reduction in grazing pressure .

Total tree pollen levels fell significantly during the Ulmus regeneration and reach a mid - zone low at the Ulmus peak . Plantago sp. and Gramineae decline to a low at 167 cm , which substantiates further , the Ulmus regeneration .

ZONE S - 5b - Continued

167 to 159 cm 2470 to 2370 extrapolated years b.p.

84a Plantago lanceolata regenerates after the Ulmus regeneration phase (phase A), together with Gramineae, thus indicating fresh clearances for pastoral activit After the Ulmus peak, Quercus rises sharply into the 163 cm horizon, after which it declines and there is a sharp increase in Betula. Alnus rises steadily, as it has done from the beginning of the zone at 173 cm. At the 159 cm horizon , Plantago sp. levels decrease slightly, while at this time Quercus is still expanding .

5.84a

The apparent contradiction of regeneration and clearance occuring at the same time may be explained in the following way :
The decline in Ulmus is real as is the simultaneous increase in Plantago lanceolata and Gramineae . The appearance of Fraxinus (167 cm .) regeneration is indicative of areas of fairly open woodland . A proportion of the Gramineae increases are local and are not affected by the regeneration of Betula at the 159 cm horizon .

In other words , the woodland is expanding relative to its N.A.P. The expansion of and subsequent closing in of the woodland reduces Corylus levels by a closing in of the canopy component . At the 159 cm horizon the total arboreal pollen peaks with 34 % of total pollen . The major T.A.P. components for this level are Betula 38 % T.A.P. , Quercus 16 % T.A.P. and Alnus 46 % T.A.P. with no Ulmus recorded .

The zone , S - 5b , marks the beginning of a series of clearances by a culture , more advanced technologically , than the preceding Bronze age peoples , (see section 7.3) .

ZONE S - 6a

159 to 140 cm 2370 to 2130 extrapolated years b.p.

6.85 Following the arboreal regeneration of woodlands in the previous zone , there follows a period of increased clearance activity with a different emphasis. This time , clearances are for arable purposes at the 155 cm and 150 cm horizons in addition to increased pastoral clearance activity at 155 cm Gramineae increases significantly throughout the zone and peaks at 140 cm with Ericaceae also showing renewed expansion , (see Figure 6.82) .

During this period of increased activity , hardwoods such as Ulmus and even Tilia partially regenerate . Corylus scrub T.A.P. steadily declines , most probably as a result of the clearances . Open woodland areas of Betula and Fraxinus are cleared particularly in latter part of the Zone, (see Fig. 6.81)

The areas of clearance activity are located on the gently sloping hillsides to the north-west of Waun Fach summit where grasslands and some heathlands are present . Arable agricultural clearances were carried out in the Wye lowlands , possibly on gently sloping ground . These Ulmus and Tilia regenerations also occur on other hillsides and lowland areas which were previously cleared . This may have been due to shifting pastoralism .

The upsurge in crop production , which must have followed clearances for arable purpose , may well mark the beginning of a new wave of peoples moving into the region , introducing new cultural practices , and settling . The effects of this migration are evident from the results shown in Zone S - 6b , and described in the section 6.85a which follows , (see correlation section , 7.2) .

ZONE S - 6b

140 to 90 cm , 2130 to 1500 extrapolated years b.p.

85a This zone marks the beginning of the most extensive clearance phase and and having the longest duration in the whole profile . Gramineae , which started increasing from 167 cm (section 6.84a) , continues to increase steadily and rises to a broad peak between the 140 cm, and 130 cm horizons (up to 58 % T.A.P.), and indication of a large expansion of grasslands .

This is then followed by a second sharp peak at 120 cm with a total of 100 % T.A.P. , and finally the highest T.A.P. 158 % at 105 cm . Corylus scrub is reduced in a series of clearances to an all time low at the 90 cm. horizon.

Plantago lanceolata records a succession of high peaks , most notably at 125 to 115 cm and at the 100 cm, horizons.. Pteridium T.A.P. peaks between 120 & 105 cm. The pastoral peak is 120 cm (1900 extrapolated years b.p) Clearances for arable agriculture are also recorded with the highest T.A.P. percentages in the whole profile .

Plantago major-media shows high T.A.P. and almost a continuous presence during the whole zone . Peak arable clearances occur at 125 cm . (1950 extrapolated years b.p.) , and at the 115 cm and 105 cm horizons . During this zone Ulmus clearances take place at four separate periods . Most tree genera present are cleared in this zone , (see section 6.81) .

Ulmus , Quercus , and Alnus are cleared in the early stages followed by Betula and some Tilia and probably by Fraxinus . Alnus and Quercus are the two main genera affected by clearances which produce much more open woodlands . The arboreal genus , which benefits as a result of the opening of the woodland canopy , is Betula . Betula flourishes as clearance activity subsides at the 100 cm to 90 cm horizons .

The historical implications and comparisons of this zone with others are discussed in the correlation section 7.2.

6.85a At the end of the Zone S - 6b , clearances virtually cease with the genera Ulmus and Tilia absent and Alnus , and Quercus severly reduced . Betula is the dominant genus growing on disused grasslands and heaths as well as on previously - used , arable areas . The next zone , Zone S - 7 , continues to record a period of reduced clearance activity .

To summarize , this zone , S - 6b , marks the beginning of a new period in agricultural practices . There is a new emphasis on arable agriculture which was first recorded as comparatively small scale clearances in Zone S - 6a . Arable clearances are noted over several centuries in Zone S - 6b . In addition , Zone S - 6b also records large scale extensive clearances for pastoral agriculture .

These pastoral clearances may well have extended on to the north - western slopes of the Black Mountains (similar to the clearances extensions which occured in Zone T - 1 , in the Ty isaf profile) . Most pastoral clearances probably occur however , on the lower hillslopes in the rolling hills of the Wye lowlands (see Fig. 6.110). Arable agricultural clearances were located in the flatter areas of the Wye lowlands , which were more suitable for crops . Such increased activity would have provided support for a much larger population . There are similar indications in the other Black Mountains profile , Waun Fach Central .

ZONE S - 7

90 to 70 cm 1500 to 1150 extrapolated years b.p.

6.86 This zone is noticable for the absence of Ulmus and only a zone boundary occurence of Plantago lanceolata . Following the very extensive arboreal regeneration culminating at the 90 cm horizon , Betula drops to half its value from 51 % T.A.P. at the 90 cm horizon to 24 % T.A.P. at 80 cm. and is the main tree component to show reductions , (see Figure 6.81) .

Ruderals and Plantago sp. show little activity in this zone . Betula is being replaced by Fraxinus showing a natural successional sequence . This is also indicated by Corylus levels increasing at the 80 cm horizon . Ericaceae and specially Sphagnum values rise sharply at 80 cm horizon , indicating a local component expansion on blanket peat situated on a ridge to the north - west of Waun Fach summit itself because Waun Fach Central and Waun Fach North profiles do not record such increase in Ericaceae and Sphagnum at this time .

The decline in Betula and subsequent regeneration of Fraxinus would probably occur on low hillsides as well as on the lowlands of the Wye valley . Alnus regeneration at the 80 cm horizon takes place along stream edges and damp gulleys on hillsides . A reduction in grazing activity occured resulting in the spread of Ericaceae plants on lower mountain slopes above areas of Pteridium . Corylus also increased on the margins of woodlands and amongst other Quercus / Betula woods .

The upper zone boundary at 70 cm , shows a Betula regeneration with total arboreal pollen values rising by 11 % . This corresponds with the appearance of Plantago lanceolata and a sharp increase in Taraxacum type and Compositae levels . This paves the way for renewed clearance activity which takes place in the adjoining upper zone . Other arboreal components during this zone indicate little change in the very open woodland conditions .

<u>ZONE S - 8</u>

<u>70 to 40 cm 1150 to 650 extrapolated years b.p.</u>

.87 This zone which covers a period of 500 years, records an almost continuous increase in pastoral clearances . There was only one interlude of arable clearances (50 cm horizon) , demonstrating a change in agricultural emphasis . This is in contrast to Zone S - 6b (section 6.85a) . Although clearances are probably widespread , they are generally of low intensity and are restricted mainly to hillslopes and lowlands . Clearances in this zone are much smaller than those in Zone S - 6b .

<u>Betula</u> continues to be a major arboreal genus with <u>Fraxinus</u> succession in the upper portion of the zone . Despite these clearances <u>Ulmus</u> regenerates up to a peak at the 50 cm horizon on unleached soils on hillsides and lowland areas . Significant areas of <u>Corylus</u> scrub were cleared up to the 50 cm horizon .

At the top of the zone at 40 cm <u>Ulmus</u> and <u>Betula</u> are both cleared , the general degree of clearance activity declining slightly . <u>Pinus</u> regenerates at this horizon probably on dry hill slopes which may well have been previous pasture areas , Merryfield. D. , (1977) .

ZONE S - 9

40 to 22 cm 650 to 350 extrapolated years b.p.

.88 Continuous marginal scrub expansion coupled with significant T.A.P. for *Fraxinus* indicate a continuation of an open woodland community similar to those in Zone S - 8 . Some selective clearances of *Ulmus* are initially experienced with subsequent regeneration on cessation of clearance activity at the close of the period .

Betula and *Fraxinus* also show increases at the top of the zone . Clearance activity is mainly pastoral with some evidence of arable agriculture indicated by the presence of cereals, as well as other ruderals , (see Figure 6.83) .

The essentially stable Gramineae and *Plantago lanceolata* pollen curves do not show any expansion of clearance activity . *Corylus* expands as a result of a greater opening of the woodland canopy and also marginal scrub expansion . At the close of the zone clearances became fewer and *Ulmus* and *Fraxinus* regenerate .

ZONE S - 10

21 to 6 cm 350 to 100 extrapolated years b.p.

6.89 A significant continual increase in pastoral clearances takes place following Zone S - 9 . Both Gramineae and Ericaceae expansion occur on hillsides probably at higher altitudes to those in Zone S - 9 .

The very open nature of woodland community is revealed by high *Fraxinus* T.A.P. percentages . *Ulmus* and *Pinus* appear briefly . Arable agriculture is indicated by the presence of *Carduus* / *Cirsium* type and cereal pollen .

The steady increase in clearance activity in this zone seems to be in response to a growing human population . Grazing areas at the end of this zone are shown to extend right up to the Black Mountains summit as they do today , Ordinance Survey maps (land use) , NO. 58 , (1805 - 1873 A D.) .

FIG. 6.81

Pollen Diagram from WAUN FÂCH South, Black Mountains

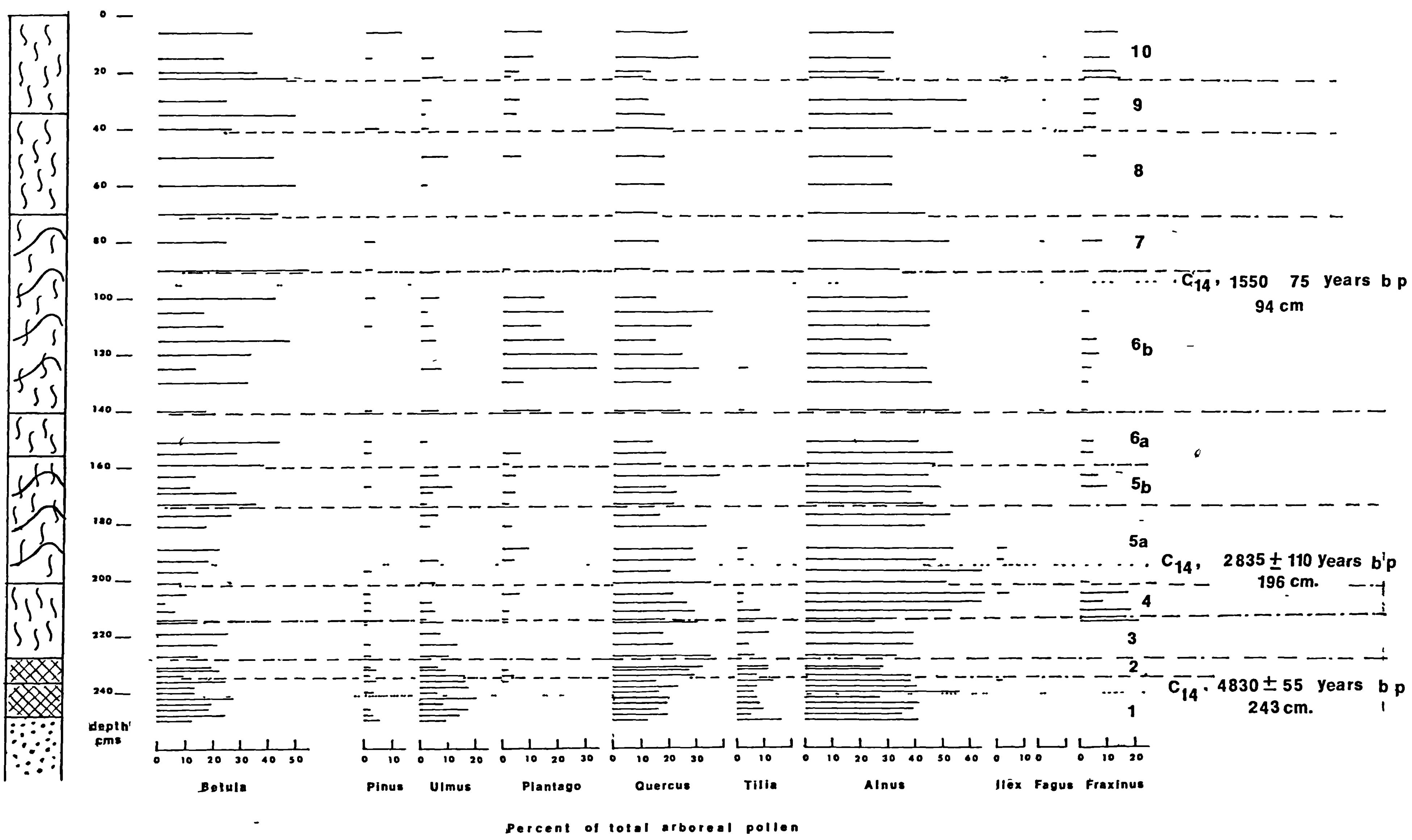


FIG. 6 82

Pollen Diagram from WAUN FÂCH South, Black Mountains

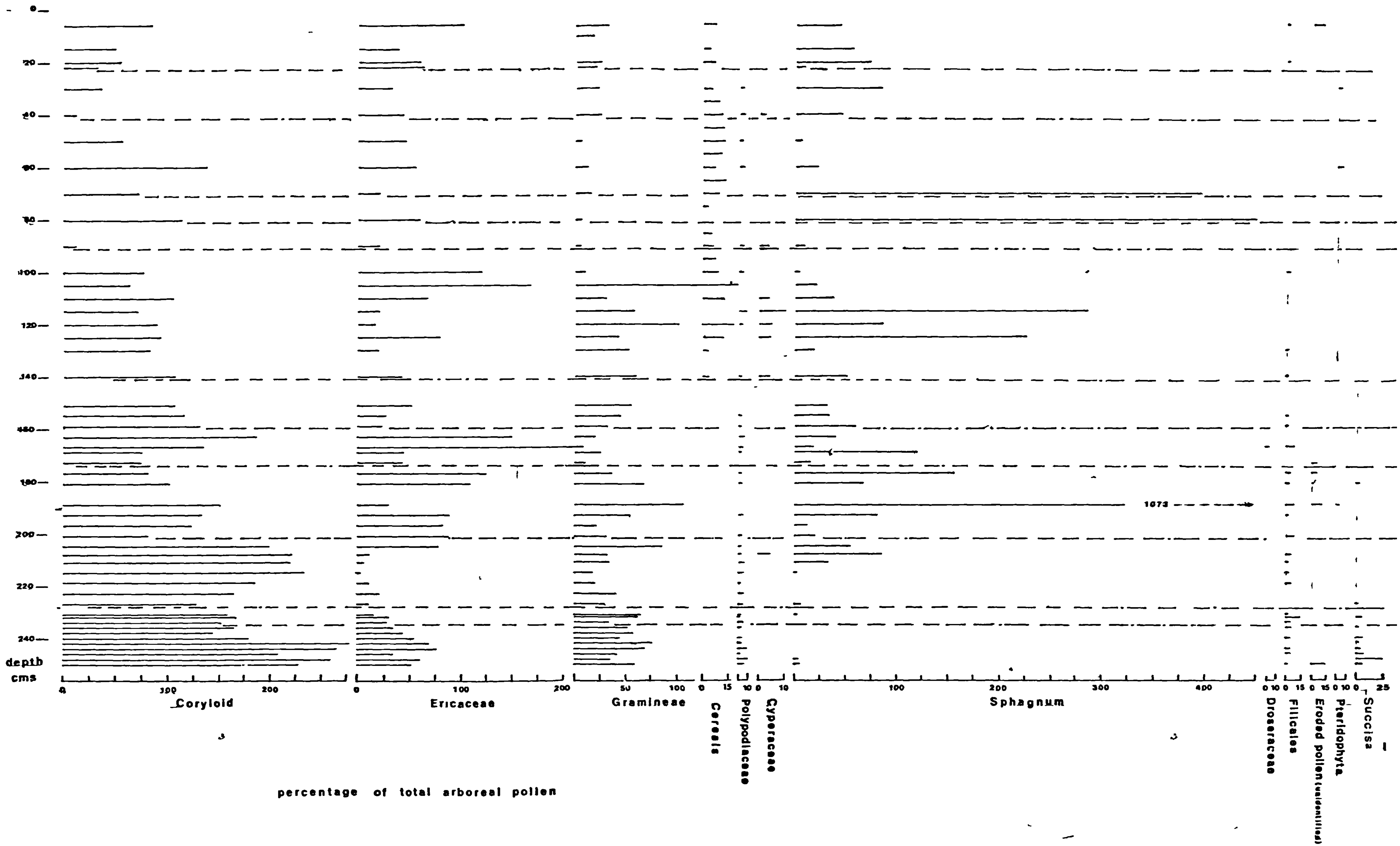


FIG. 6 83

Pollen Diagram from Waun Fach South, Black Mountains

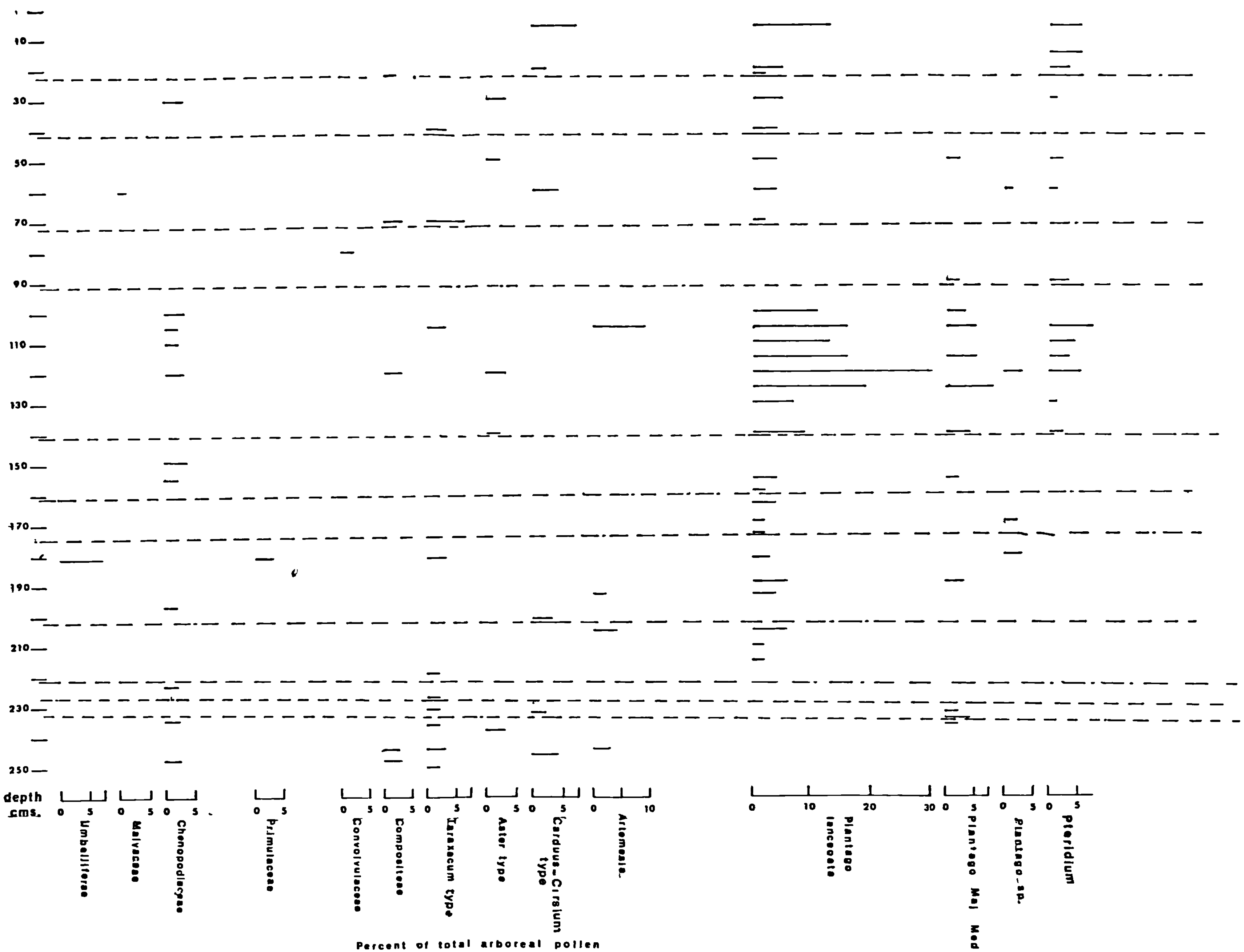
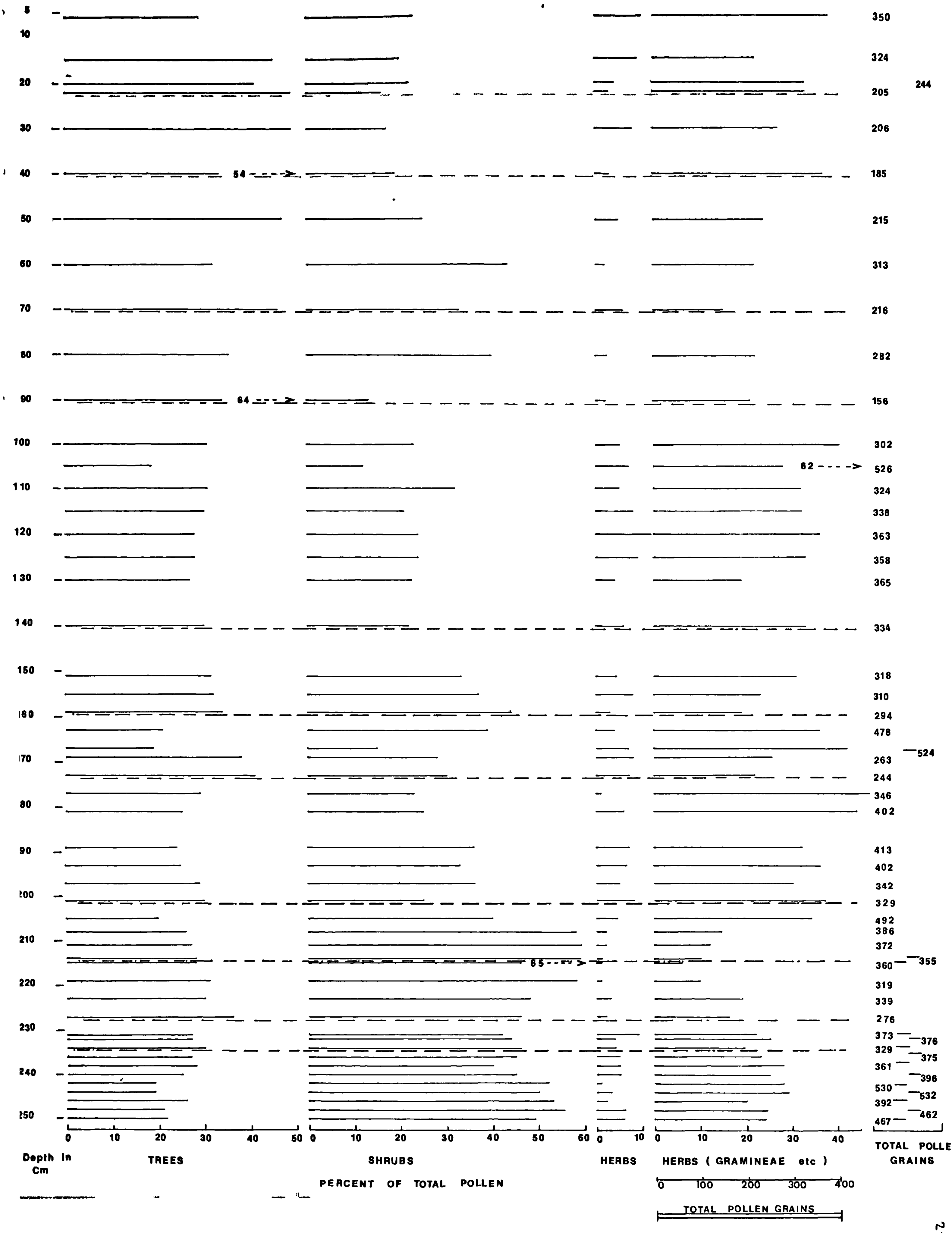


FIG. 6.84 POLLEN DIAGRAM FROM WAUN FÂCH SOUTH BLACK MOUNTAINS



DISCUSSION OF THE WAUN FACH NORTH PROFILE ON WAUN FACH SUMMIT , BLACK MOUNTAINS

6.9

Section	Zone	Peat depth in cm	Extrapolated years b.p.
6.98	N - 8	30 to 40	480 to 650
6.97	N - 7	40 to 60	650 to 1150
6.96	N - 6	60 to 75	1150 to 1500
6.95	N - 5	75 to 135	1500 to 2370
6.94	N - 4	135 to 180	2370 to 3050
6.93	N - 3	180 to 210	3050 to 4350
6.92	N - 2	210 to 227	4350 to 5100
6.91	N - 1	228 to 230	5100+ to ?

Note : All dates on this profile are taken by comparison with the radio-carbon dated profile , Waun Fach South , and the basal Ulmus decline on the Waun Fach North profile .

See Figures 6.91 to 6.94 inclusive .

ZONE N - 1

230 to 228 cm ? to 5100 extrapolated years b.p.

6.91 The most notable feature of this portion of the profile is the high T.A.P. values for *Pinus* and the low *Alnus* values, which occur in this zone. These relative values are abruptly reversed in the next zone, N - 2, above, where there is a sharp drop in the *Pinus* count and sharp rise in *Alnus*. This combination of events could possibly indicate that the base of this profile is at the start of the Atlantic period, Godwin H. (1940), Simmons I.G. (1964).

The high *Pinus* value of 18 % T.A.P. (4.7 % T.P.), in Zone N - 1 is not only the highest in this zone, but is higher than on all other Black Mountain profiles. *Alnus* has the lowest levels in the profile with 8 % T.A.P. (2 % T.P.), and the lowest levels in any of the Black Mountain pollen profiles, (see Figures 6.51 to 6.91 inclusive).

Betula T.A.P., which are high in Zone N - 1, drop sharply with *Pinus* in Zone N - 2. Both *Quercus* and *Tilia* increase. *Corylus* values remain at about 190 % T.A.P. Ericaceae remains at a low level throughout the Zone N - 1, (below 15 % T.A.P.), and Gramineae increases marginally and erratically. Ruderals are particularly high in this zone, relative to other zones. This is indicative of open areas in the woodland canopy and is probably a local occurance, total arboreal pollen decreases steadily to 228 cm

It is suggested that, the declining *Pinus* with increasing Alnus T.A.P. which meet at the 228 / 227 cm horizon, represents the Boreal/Atlantic transition VI / VIIa.. The classical date of this transition as suggested by Godwin H. (1959, and 1960), is about 7500 years b.p. Basal dates for peats, proposed by Conway V.M. (1947 and 1954) are also, in the Atlantic period.

Smith A.G. and Pilcher J.R. (1972) , published an interesting article suggesting that there are wide variations in the radio-carbon dates for this Boreal / Atlantic transition . The rational limits of the Alnus (the point at which the pollen curve begins to rise to sustained high values) , ranged from 7700 to 5100 radio-carbon years b.p. , using data from 15 separate sites in Ireland , England and Scotland .

Mitchell G.F. (1955), proposed dates,for the Boreal / Atlantic transition , which , extends from 8500 to 4800 radio-carbon years b.p. , using data from 12 separate sites from Ireland , England and Scotland .

Some of the above sites indicate that the Boreal / Atlantic transition is at the same date as the Ulmus decline or chronologically very close to Ulmus decline , as Table 6.91 indicates .

TABLE 6.91

Site	Author of diagram	Rational *Alnus* limit years b.p.	Decline of *Ulmus*	Mitchell Boreal/Atlantic transition
Ballynagilly Co. Tyrone	Pilcher J.R. (1970)	5145 ± 70	5145 ± 70	5145 ± 70
Gortcorbies Co. London-derry	Goddard I.C. (1971)	5160 ± 75	5160 ± 75	5160 ± 75
Altnahinch Co. Antrim	Goddard. A. (1971)	6340 ± 100	4880 ± 105	4880 ± 105
Beaghmore Co. Tyrone	Pilcher J.R. (1969)	6050 ± 60	5285 ± 70	5295 ± 75
Slieve Gallion Co. Tyrone	Pilcher J.R. (1973)	6200 interpolated	4895 ± 65	5150 interpolated

Note : All dates are radio-carbon years b.p. , or interpolated dates where indicated .

Smith A.G. and Pilcher J.R. (1973) , summarize their findings by stating " within the limits of the method the final Pinus decline in Ireland examined first by Jessen K. (1949) appears to be one of the least synchronous of the horizons examined." "Marked differences in the date of similar vegetational changes within a small area , and between upland and lowland are pointed out" .

On Waun Fach North, the abundance of Polypodium and Succisa in a thin basal mor humus layer , suggests that these horizons were beneath an open woodland . The date of the transition VI / VIIa , appears to be just before the Ulmus decline in Zone N - 2. However , accumulation rates in these basal horizons may have been extremely slow .

The occurrence of a VI / VIIa transition just below the Ulmus decline has been noted by other reasearchers (see Table 6.91) . Moore P.D. (1968) , in his Mid - Wales profile from Plynlimmon (altitiude 640 metres.) , has a sharp Pinus decline and Alnus increase in mor humus , just below the Ulmus decline .

ZONE N - 2

227 to 210 cm. 5100 to 4350 extrapolated years b.p.

227 to 226 cm.

6.92a Total arboreal pollen levels decline at 226 cm . with a sharp increase in herbs but a slight decrease in Gramineae . Betula continues to decrease in this period in the profile . Pinus , after its initial sharp decline , increases by about 2 % T.A.P. overall . Ulmus falls sharply whereas Tilia and Alnus increase steadily throughout this period .

The continued decline in Betula and Corylus together with a continued increase in Alnus are seen as a continued closure of the woodland canopy . No sharp increases in Gramineae or Ericaceae are detected indicating a stable local enviroment without large areas being opened up .

This portion of the profile could well represent the beginning of the Sub - Boreal period (Zone VII_b , using Godwin's notation) , Ulmus and Betula both decline sharply . This is probably due to the increasing Alnus T.A.P. , Godwin H. (1940) .

ZONE N - 2

225 to 218 cm

6.92b Total arboreal pollen % fall steadily to a low (26 % T.P.), at 221 cm then rising steadily to a peak at 218 cm (34 % T.P.). Corylus pollen rises steadily during the arboreal decline but peaks at 220 cms (45 % T.P.), a rise of 8 % T.P. from the 225 cm horizon then declines slightly towards 218 cm.

Gramineae pollen peaks at 221 cm (a doubling in terms of T.A.P.) with a pollen herb peak of 24 % T.P. ; ruderals increase and peak at 222 cm . with 9 % of T.P.

The increase in ruderals particularly of Carduus / Cirsium type , Rosaceae , Taraxacum type and Umbelliferae ; the sharp Gramineae increase , and the corresponding decline in arboreal pollen , are indicative of an opening up of woodlands followed by the growth of these herbs .

These clearances could well be woodland clearances by man and grazing animals . Alternatively the Gramineae peak may be just a local expansion close to the sample site. The high ruderals T.A.P. percentages particularly Taraxacum type , Carduus / Cirsium type , and Umbelliferae are commonly indicative of arable agriculture or freshly exposed soil , Pennington , W. (1969) , Moore , P.D. and Chater , E.H. (1969) , Tallis , J.H. (1964) , and Walker , M.F. & Taylor , J.A. (1976) . In this instance the latter is more probable at these altitudes .

A proportion of the high T.A.P. for Corylus in this and other basal zones could well be due to local upland clearance . Both high T.A.P. for Corylus and Betula , and an abundance of ruderals indicative of disturbance are common on all three Waun Fach profiles. These arboreal genera are considered of local occurance as well as representing lower areas in the Grwyne Fawr valley , (see Figure 6.110) .

ZONE N - 2

218 to 216 cm

6.92c The partial recession in clearance at 218 cm is followed by intense clearance just 1 cm above at 217 cm a fall of 12 % T.P. , with shrub levels rising sharply by 8 % of T.P. , and herbs and ruderals both increasing by 2 % of T.P.

The arboreal removal is mainly of *Betula* and some *Alnus* and possibly *Tilia* . *Quercus* rises sharply at 217 cm but the high *Corylus* T.A.P. suggest that either *Quercus* is abnormally high because other tree genera are at low levels , or *Quercus* is expanding elsewhere in the woodland .

The arboreal total tree pollen low does not have all the usual indicators of human activity , but it remains a possibilty , that it was a product of human activity (see section 4.3 and Figure 7.52) .

From 217 cm upwards to 215 cm , total arboreal pollen levels rise by 14 % to 36 % of T.P. *Betula* is the only tree increasing , indicating an opening up of the forest canopy and a filling - in of grassland areas .

ZONE N - 2

216 to 210 cm

6.92d The arboreal lows are encountered at 215 cm and 212 cm. At 215 cm all tree species except Betula increase dramatically but in real terms this is an overall arboreal decline of 8 % of T.P. Corylus makes up for most of this increase and there is some herb expansion indicating a more open woodland canopy .

Corylus is a copious producer of pollen and this may have been simply a period when Corylus produced more pollen than usual . It could mean however development of Corylus scrub as Dimbleby , G.W. (1961) suggests when high values of Corylus are obtained . This high level 51 % of T.P. at 215 cm , may indicate the firing of woodland to provide grazing land , Corylus being resistant to fire and a fast growing species Smith , A.G. , (1970) .

Arboreal % T.A.P. increase for a period , with a closing in of the canopy and a reduction in Corylus . However , Corylus again expands at 213 cm to 45 % T.P. , 164 % T.A.P. , with a corresponding reduction in herb levels . This may also have been caused by local firing .

The second arboreal pollen low (26 % T.P. , 212 cm), represents a Gramineae expansion coinciding with increases in Umbelliferae and Compositae , suggesting clearances of woodlands for grazing .

Betula and Quercus decline . These are the two types found at the base of the peat on Pen y Gader-Fawr (see Fig. 6.61 , section 4.3). Tilia and Alnus increase and Ulmus reaches its highest level with 38 % T.A.P. This figure may be exaggerated , due to the arboreal pollen low at this 212 cm horizon . At 211 cm arboreal levels increase to 37 % T.P. with Ulmus dropping to 23 % T.A.P. Pinus regenerates and Betula increases . Ruderals are extremely low at this horizon .

6.92e To conclude , this unique zone records the highest Ulmus T.A.P. percentages of any Black Mountains profile , or , of any other post glacial profile in Wales . Ulmus often reaches 30 % and , at one stage , nearly 40 % of all arboreal pollen , this suggests a local origin .

The area represented on this profile is the Grwyne Fawr valley (reasons for this location are given in section 6.110 (see Fig. 6.110) . Many of the fluctuations in both Betula and Ulmus are in response to the expansion of Alnus at the beginning of the Sub - Boreal period , Conway , V.M. (1947). Pinus has just the opposite trend and declines in this zone with the lowest T.A.P. percentages occuring between the 219 and 210 cm horizons .

All floristic disturbances recorded in this zone occur on the top of the valley , in the upland areas of the Grwyne Fawr valley , which forms the western watershed of the valley (Grwyne Fawr valley) , (see Figure 6.110) .

This mountain area was already partially cleared of trees on the Waun Fach summit before peat initiation . There had been periods of intermittent small scale clearances . On this upland area Betula , Quercus and Corylus are the main genera present in an open , mixed woodlands community .

Clearances were for grazing purposes . The arboreal flora in the Grwyne Fawr valley itself was more dense . Quercus , Ulmus , Alnus and Tilia were the main genera , and with low Fraxinus T.A.P.

The initial fall in Ulmus T.A.P. above the 227 cm horizon , is taken to be the start of the "Ulmus" decline , described by Godwin H. (1940) . This is accompanied by the appearance of several ruderals namely , Taraxacum type , Umbelliferaeae , Chenopodiaceae , Rosaceae and

Compositae . This is the first of five Ulmus clearance phases in which Ulmus and sometimes Tilia are selectively cleared .

If circa 5000 to 5100 years b.p. is taken to represent a reasonable average of the generally synchronous Ulmus decline , Smith A.G. and Pilcher J.R. (1973) . Then approximate dates of these clearances are shown in Table 6.95 . They extend from 227 to 210 cm . ; 5080 to 4350 years b.p.

These clearances appear as small selective clearances which allow Ulmus to fully regenerate after clearances have ceased .

Note : It should be noted that , because , radio - carbon dates were not taken on this profile , it is impossible to state without reservations that the 227 cm horizon is the start of the Ulmus decline . A less favoured alternative is the fall in Ulmus T.A.P. starting at 207 cm horizon ,with the appearance of the Plantago - sp. at 204 cm

ZONE N - 3

210 to 180 cm 4350 to 3050 extrapolated years b.p.

6.93 Following the series of dramatic fluctuations in Ulmus in the Zone N - 2 , Ulmus % T.A.P. rise at the 207cm horizon. From 207 to 201 cm Ulmus is selectively cleared and is again cleared at 198 - 192 cm This coincides with the appearance of Plantago sp. between the 204 cm and the 192 cm horizons (see Figure 6.91) .

Ruderals , indicative of exposed ground , pastoral agriculture and of general disturbances in woodlands , are recorded over the same horizons of 204 to 192 cm Pinus is cleared several times at the 210 to 207 cms. , 204 to 201 cm. and at the 186 to 180 cm horizons .

Tilia actually benefits from these clearances and reaches nearly 20 % T.A.P. at the 189 cm horizon . Total tree pollen substantially increases during this zone and rises in two peaks at 198 cm and 192 cm , and culminates in the highest peak of all at the 180 cm horizon .

Corylus , in this zone , drops sharply in an almost uninterrupted decline to an all time low at the 180 cm horizon . Gramineae and Ericaceae show sharp declines also during this period , indicating a reduction in local heathlands and grasslands .

Perhaps the most interesting trend in this zone is the drop in the Betula T.A.P. percentages starting with the first appearance of Plantago sp. at the 204 cm horizon . Though Betula regenerates partially , there is a net decline for the whole zone at 180 cm

The fall in Betula is particularly interesting because it suggests that previous Betula T.A.P. levels were extremly high during the previous horizons in Zone N - 2 , due to the low Alnus T.A.P. percentages and the local occurence of Betula to, Waun Fach North .

The apparently contradictory floristic picture of substantial arboreal regenerations (mainly Quercus and Tilia) , during a prolonged period of clearances , (Plantago sp. is recorded at 204 to 192 cm) , is explained as follows :

The Waun Fach North profile represents the densely forested Grwyne valley . The valley is virtually inaccessable and has little agricultural potential . It lies in the very heart of the Black Mountains and is surrounded by mountains of over 615 metres in altitude. The arboreal flora of this valley is a Quercus , Ulmus , Alnus , Tilia woodlands with greater proportions of Alnus occuring in gulleys and along stream banks (see section 6.110, Fig. 6.110).

The western ridge of this valley in particular , Pen y Gader-Fawr and the connecting ridge to Waun Fach , had a more open woodland than neighbouring valleys . On this flattish , gently - sloping ridge , Betula grew with Ulmus , Quercus , Pinus and Tilia . It was on the eastern watershed of this upland area that different portions of the forest were cleared .

The time period in which Plantago sp. were recorded is between 4100 to 3600 extrapolated years b.p. This spans the time when peat initiation started on Pen y Gader-Fawr . The discovery of pieces of Quercus and Betula wood underlying Pen y Gader - Fawr peats gives further support to this explanation (see Zone G - 1 , section 6.61 and section 4.3) .

This facinating discovery is discussed further in section 7.4 , in the next chapter . Surface pollen studies collected from the Waun Fach North indicate that it is possible for this site to record pollen which came from eastern watershed of Pen y Gader-Fawr (see sections 6.110 & 3.7).

ZONE N - 4

180 to 135 cm 3050 to 2370 extrapolated years b.p.

6.94a Following an arboreal peak at the 180 cm. horizon there follows a net decline in arboreal total pollen in this zone . This is due to a marked expansion in local pollen components . Gramineae T.A.P. percentages are generally much higher in this zone indicating mainly a local expansion of grassland , but , are also due to some woodland clearances .

Gramineae first peaks at 165 cm , with lesser peaks at 145 cm and 135 cm Ericaceae also sharply increases at the 135 cm horizon with the reappearance of *Plantago lanceolata* , *Fil ipendula* and Chenopodiaceae . This indicates woodland clearances for pastoral and arable agriculture .

Ulmus T.A.P. drop steadily from 175 cm. onwards reaching a low at 165 cm *Pinus* and *Tilia* also decline over the same period . *Betula* T.A.P. , after dipping slightly from the 180 cm. horizon remain essentially stable . A continuous and very noticable increase in *Alnus* takes place from 180 cms. to 145 cm but is depressed at 140 cm because of a *Betula* peak . Afterwards , *Ulmus* continues to increase .

The fall in *Ulmus* , *Pinus* and *Tilia* corresponds to a total arboreal pollen decline and is thought to be a clearance of woodland by human activity. This may have been caused by felling trees with axes , Iversen , J. (1941). ringing of trees,Pennington , W. (1969) , and/or by grazing animals removing the nutritious tree seedling , or by , the removal of bark and/or leaves for fodder , Moore , P.D. and Bellamy , D.J. (1974) .

Ruderals total pollen is high at 165 cm , but *Quercus* makes the largest increase . This *Quercus* increase is exaggerated because of the overall reduction in total arboreal pollen , relative to total pollen .

Ulmus , *Pinus* and later , *Tilia* regenerate from the 165 cm horizon , up to 155 cm for *Pinus* and *Ulmus* and to 150 cm for *Tilia* . Gramineae are at a low level . Total arboreal pollen remains fairly steady , then drops at the 135 cm level to 32 % T.P. from 38 % T.P. This coincides with the reappearance of *Plantago lanceolata* , *Filipendula* & Chenopodiaceae, indicating a clearance of *Betula* , *Quercus* and *Tilia* . *Corylus* increases during this period confirming the opening up of woodlands .

In this zone there is a net decline in *Ulmus* T.A.P. percentages . The first decline occurs between the 175 - 165 cm horizons and has two components . In the first component *Ulmus* declines without any indication of ground clearance .

This could be due to *Ulmus* branches being trimmed to provide winter fodder , Pennington, W. (1969) . The trimming procedure would inhibit flowering and pollen production .

The second component involves actual clearances of this genus at the 165 cm horizon , together with *Quercus* at 160 cm. The partial regeneration of *Ulmus* up to the 155 cm horizon is a direct result of the cessation of clearance activity . The 150 cm horizon marks the beginning of a new reduction in *Ulmus* .

A possible explanation for this is that repeated upland clearances caused increased surface run - off down the slopes of the Grwyne Fawr valley . This resulted in increased leaching of soil nutrients in the slope soils . The depleted soils which remained were less favourable for *Ulmus* , causing a gradual reduction of the genus . This is also demonstrated by a steady increase in *Alnus* which is more suited to wetter soils, Mitchell G.F. (1965).

The end of the zone mark the commensement of a new clearance phase which appears in Zone N - 5 .

An interesting feature of Zone N - 4, is the general decrease in <u>Betula</u> T.A.P. percentages. This indicates a quieter period with fewer disturbances to the flora in Grwyne Fawr valley.

The probable location of the first clearance activity was on the western ridges of the Grwyne Fawr valley (165 cm horizon). The location of renewed clearance activity at the 135 cm horizon could be either on the western ridge of the Grwyne valley or at the mouth of the valley. The historical implications and correlations with other Black Mountains profiles are discussed in section 7.3, period C.

ZONE N - 5

135 to 75 cm. 2370 to 1500 extrapolated years b.p.

6.95a Total arboreal pollen %, decrease steadily from 130 cm. to 105 cm, from 44 % to 28 % T.P. The greatest fall between horizons is from 130 to 125 cm. with *Plantago lanceolata* still recorded ; Gramineae doubles in T.A.P. (26 to 52 % T.A.P.), and Ericaceae rises from 14 to 23 % T.A.P. suggesting expansion of heaths and grassland on hill sides.

There is a total increase in herbs of 6 % in T.P. *Ulmus* has recovered and *Quercus* rises sharply also at the 125 cm horizon, but this is the result of *Betula* and *Alnus* decreasing and is, therefore, an artificial rise. These represent the main clearance horizons.

The steady arboreal pollen decline coincides with the steady rise in *Corylus* pollen to a peak at 105 cm. with 56 % of total pollen, and a *Betula* peak of 7 % T.P. This is a reasonable response to a thinning of the woodland canopies.

Ulmus falls very gradually, being slightly depressed by a small selective clearance at 115 cm . When *Plantago lanceolata* reappears. *Tilia* actually peaks at the 115 cm and therefore, is not selectively cleared with *Ulmus*.

At 100 cm. *Plantago lanceolata* reaches its highest peak of 9 % T.A.P., corresponding to a herb peak of 25 % T.A.P., and a ruderal peak of 4 % T.A.P. *Alnus* and *Betula* reduce at this horizon with *Ulmus* and *Tilia* actually increasing. This indicates a removal of *Betula*, *Alnus* and *Corylus* shrub in marginal wood - lands and pockets of shrub in the valleys. At 95 cm. there is a substantial rise in total tree and shrub pollen. *Ulmus* and *Pinus* have dipped at this level with *Alnus* rising sharply with *Corylus*. A fairly open woodland is indicated by this floristic composition in the Grwyne Fawr valley.

ZONE N - 5

95 to 85 cm 1780 to 1630 extrapolated years b.p.

6.95b Total tree pollen levels fall sharply at 90 cm with a sharp increase in Gramineae pollen (11 % to 33 % T.P.) . Plantago lanceolata pollen doubles , and Ulmus at this point is regenerating with Tilia reappearing . Quercus appears to have been the only tree , selectively cleared at this level .

Corylus does fall at this level in areas where the canopy is closing with the regeneration of Tilia and Ulmus . At 85 cm Quercus and Ulmus regenerate to the total tree pollen peak of 36 % of T.P.

The reappearance of Plantago major-media at 85 cm indicates that woodland clearance for arable agriculture is taking place . The only archaeological remains in the valley is the Twyn - y - Gaer hill fort at the mouth of the Grwyne Fawr . This is the most probable location of these clearances (see Figure 7.2 , section 7.2) .

.95c To summarise , the initial clearance phase between 135 to 125 cm was most severe at the 130 cm horizon , when Ulmus fell to its lowest levels on the profile . The location of clearances was,possibly up to 6 kms. away , at the mouth of the Grwyne Fawr valley . Here clearance probably occured on the gently sloping sides of the valley close to the Silures hill fort (Twyn - y - Gaer) , built at about the same time .

The selective nature of these clearances (including Tilia), suggest the utilization of Ulmus and Tilia leaves and bark for winter fodder . The continued steady decline in Ulmus between 125 cm and 105 cm (2200 to 1926 extrapolated years b.p.) , and the expansion of Betula up to the

105 cm horizon , does suggest woodland disturbances . This may again be the effects of upland clearances not recorded on Waun Fach North . That is to say the subsequent increase in run - off into the Grwyne Fawr valley probably leached soils on the slopes and made conditions less favourable for Ulmus .

A deterioration in climate is ruled out , because , Waun Fach Centre and Waun Fach South do not show this Ulmus decline. Clearances resume at 100 cm. horizon involving Alnus and later , Ulmus and Tilia . These clearances were mainly for pastoral agriculture , except for one arable clearance at 85 cm. horizon (1630 extrapolated years b.p.) .

At the 75 cm horizon , clearance activity reduced , allowing the regeneration of Ulmus , Quercus and Betula woodlands . The location of clearances was probably at the mouth of the Grwyne Fawr valley . At this time , it is possible that a small tribe sought protection in the old hill fort Twyn - y - Gaer following the departure of the Romans (see section 7.2) .

ZONE N - 6

75 to 60 cm 1500 to 1150 extrapolated years b.p.

6.96 The 75 cm horizon marks the last major total tree pollen peak (48 %) . From 75 cm upwards , total tree pollen percentages never increase to over 38 % of total pollen . Ruderals and herbs are well represented and Plantago lanceolata is recorded on every horizon .

In this zone , Ulmus steadily declines to the zone boundary at 60 cm. Betula increases sharply up to 60 cm with only a brief clearance at 65 cm , coinciding with a Plantago peak (1250 extrapolated years b.p.) .

The slight lull in clearances at 60 cms. allows Betula to expand over previously cleared areas . The locations of these clearances is again in the mouth of the Grwyne Fawr valley . This is the area of greatest agricultural potential . It is a developing region with access to the more populous communities along the Usk river .

ZONE N - 7

60 to 40 cm 1150 to 650 extrapolated years b.p.

6.97 This zone records the largest clearance phase on the whole profile . *Plantago lanceolata* begins to increase from 55 cm (1028 extrapolated years b.p.) and peaks at the 50 cm horizon (900 extrapolated years b.p.), with nearly 32 % T.A.P. Clearances steadily decline from this peak to the 40 cm horizon .

Gramineae and Ericaceae rise steadily in this zone indicating an expansion of grasslands and heathlands . *Corylus* reaches a peak at the time of maximum clearances , indicating opening of the woodland canopies . Arboreal genera cleared are *Betula* , *Alnus* and to a lesser degree , *Ulmus* and *Pinus* .

The peak in clearance activity at 900 years b.p. (11th century) , corresponds to the Agrarian revolution as this period is often called , Bowen, E.G. (1977) . The reappearance and peaking of *Plantago major - media* (at 50 cm .) , is indicative of arable agriculture and is further evidence that this could well be the start of the Norman period .

The location of these pastoral clearances was probably at the lower end of the Grwyne Fawr valley in damp woodlands situated on rolling hillsides . Arable clearances would occur on the more lowland areas in the same area . At the end of the zone (40 cm) , *Betula* , *Pinus* and *Ulmus* regenerate as clearance activity declines . *Corylus* becomes overshadowed by the higher trees and has a restricted pollen dispersal .

ZONE N - 8

40 to 30 cm . 650 to 480 extrapolated years b.p.

6.98 Clearance activity continues to decline to the 35 cm horizon with the continued regeneration of *Alnus* and *Quercus* . Local pollen components, Gramineae and Ericaceae , decline throughout this zone with *Betula* .

At the 30 cm horizon *Plantago lanceolata* increases while *Ulmus* , *Alnus* and *Betula* are being cleared. The location of clearance continues to be at the mouth of the Grwyne Fawr valley , where newly growing townships required an increasing food supply (see Figures , 6.110 and 7.1) .

Plate 6.3

Infra-red photograph of northern buttress peaks of Black Mountains , showing differential colouring of vegetation and areas of drainage .

FIG. 6 91

Pollen Diagram from Waun Fach North, Black Mountains

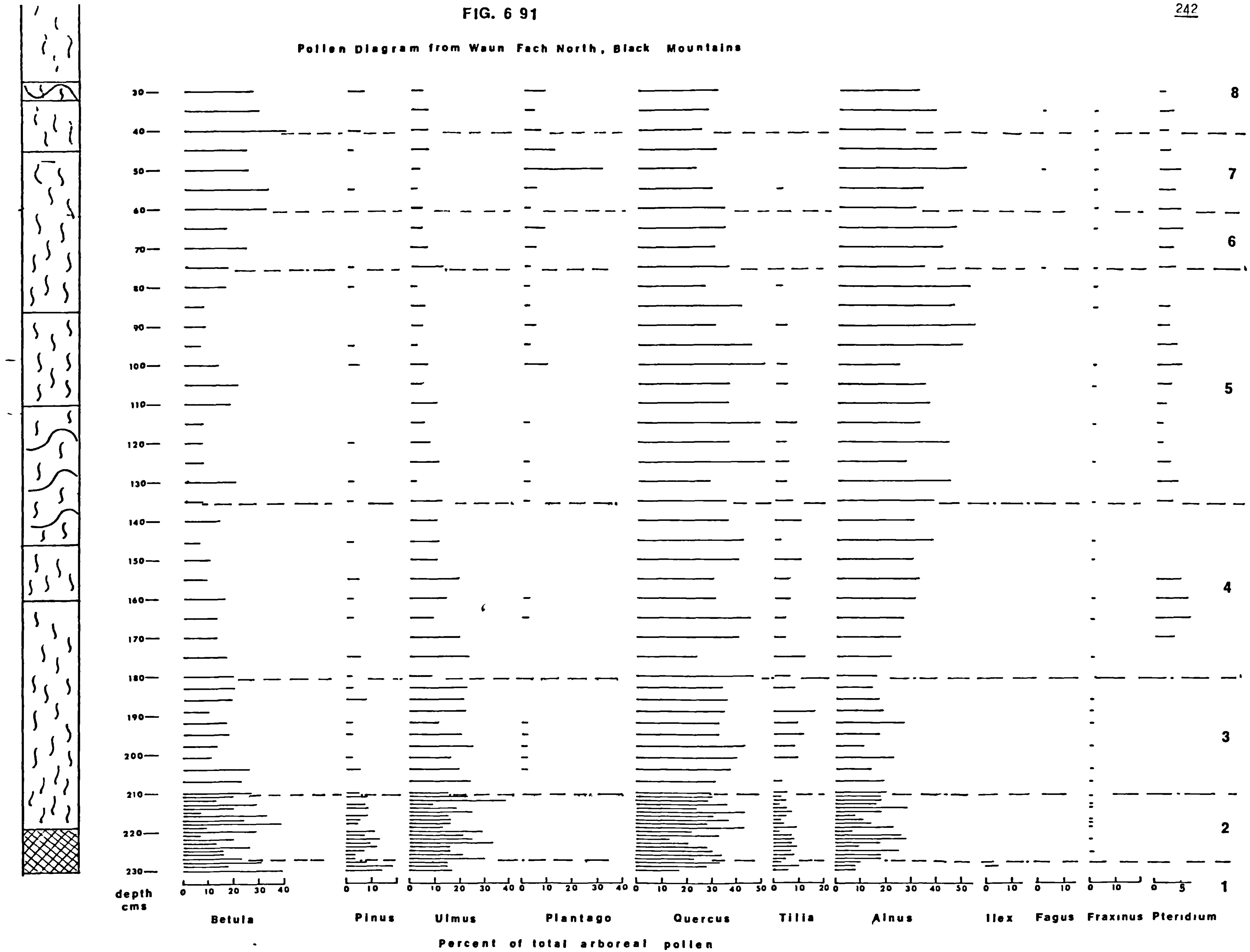


FIG 6.92

Pollen diagram from WAUN FÂCH North, Black Mountains

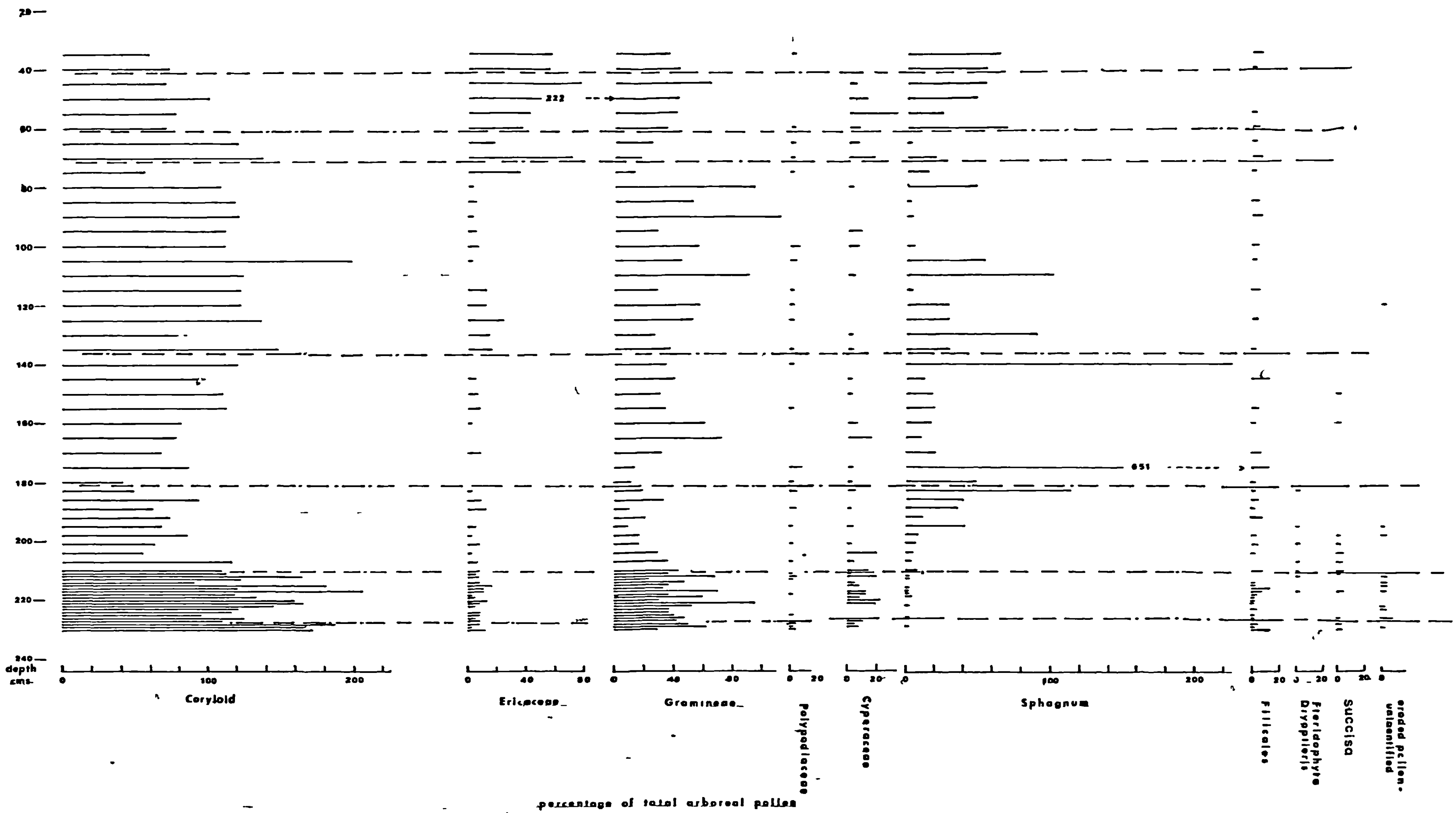


FIG. 6.93

Pollen Diagram from WAUN FÂCH North, Black Mountains

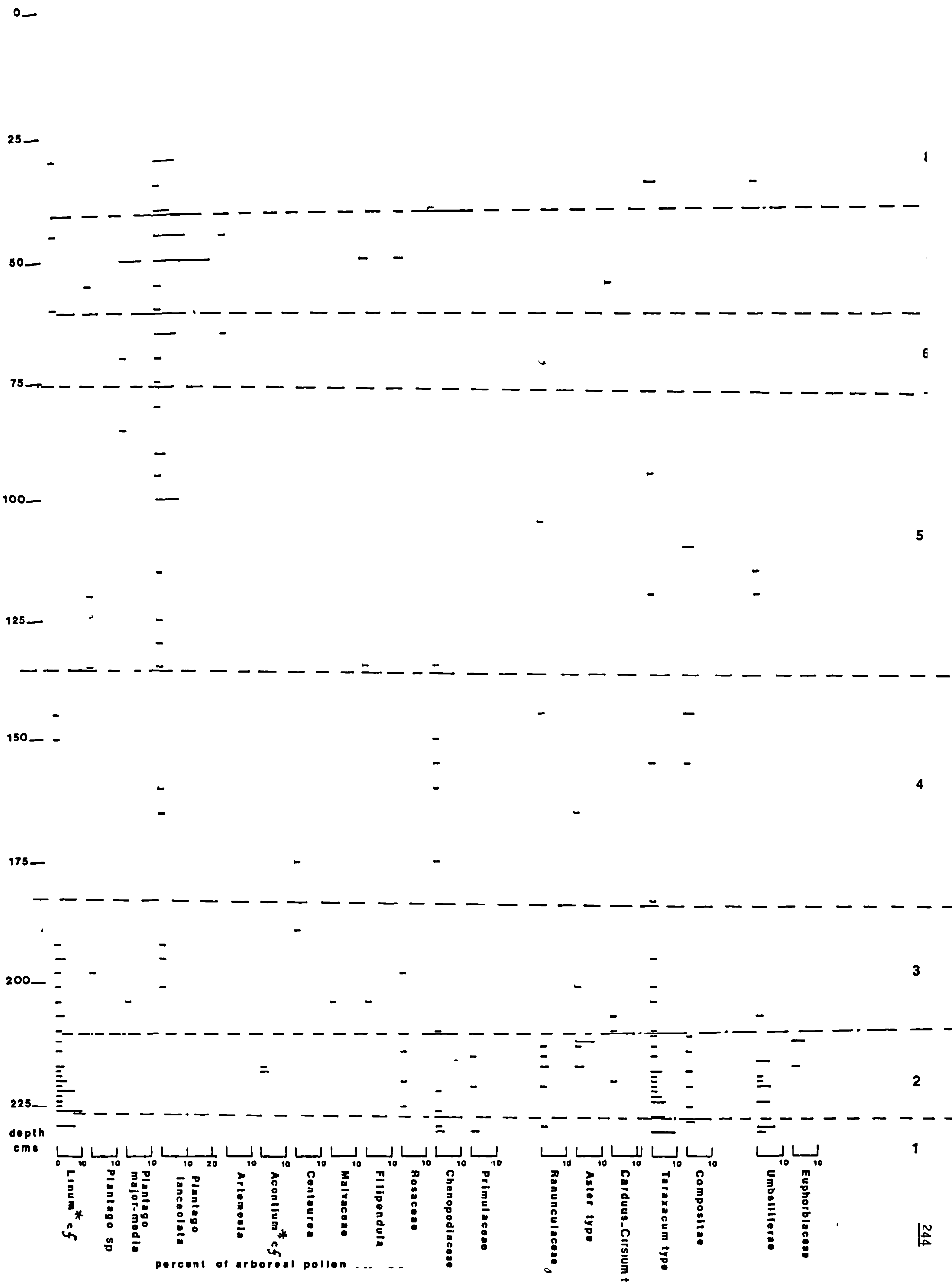
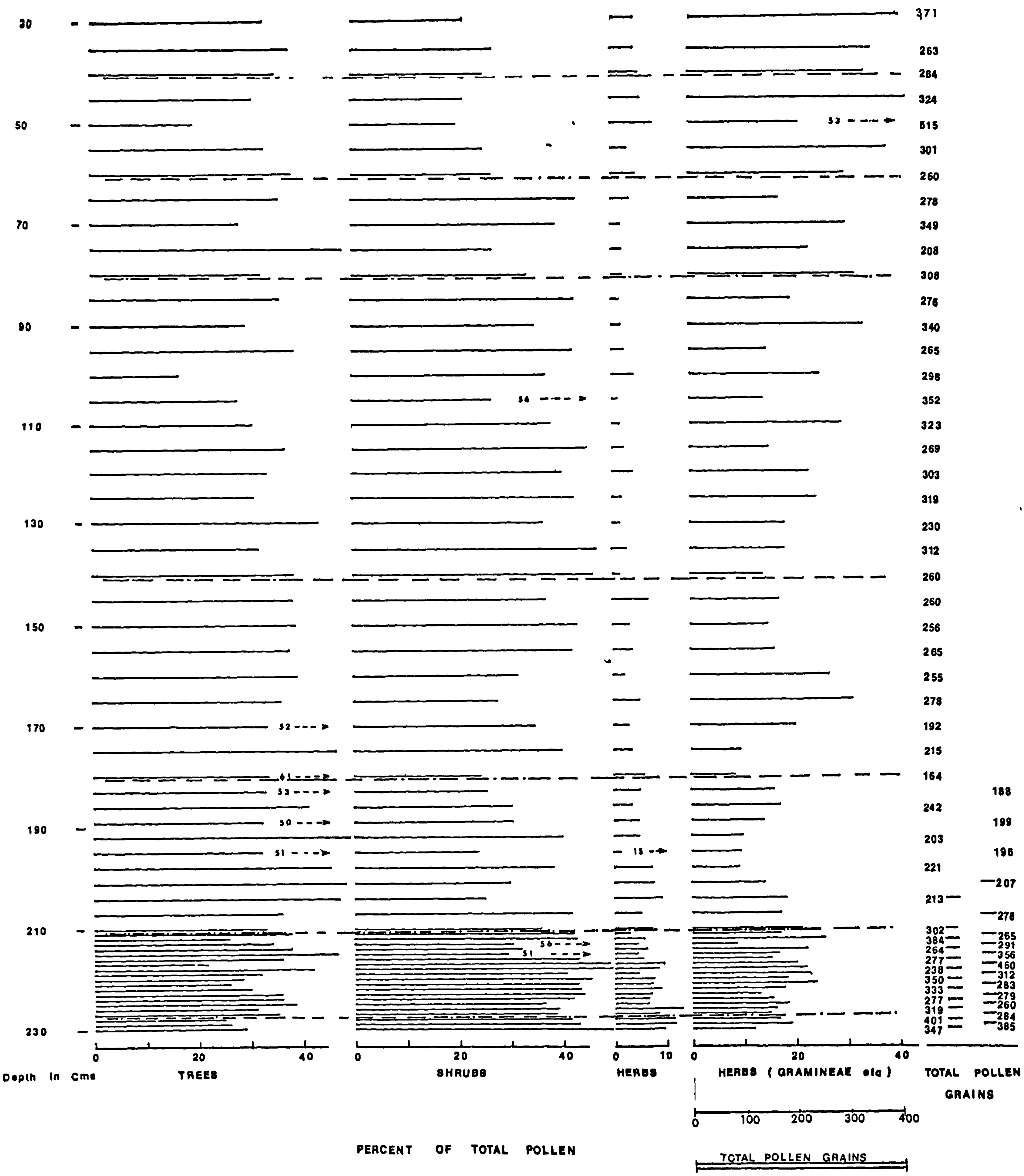


FIG. 6.94

POLLEN DIAGRAM FROM WAUN FÂCH NORTH, BLACK MOUNTAINS



THE ULMUS DECLINE IN THE BLACK MOUNTAINS AREA

6.100 The classical " Ulmus decline " as described by Godwin . H . (1940) ; Conway . V . M . (1947) ; Pennington . W . (1965) ; Moore . P . D . (1968) and Merryfield . D . and Moore . P . D . (1974) , occurred around 5000 years b.p. on sites in north-western Europe . Several workers however , have found even earlier dates for the " Ulmus decline "; 5300 to 5100 years b.p. for Smith .A.G. and Pilcher . J.R. (1973) , and 5490 ± 140 years b.p. for Bartley . D.D. (1975) .

The Ulmus decline on Waun Fach follows a somewhat erratic pattern . A time datum is provided by a radio-carbon date of 4830 ± 55 years b.p. on the 243 cm horizon on the Waun Fach South site . This gives the basal horizon at 250 cm an extrapolated date of 5127 years b.p.

The first sharp reduction in the Ulmus peak did not occur however, until 4872 and 4700 years b.p. (extrapolated) , but there was no corresponding appearance of Plantago sp. The decline in Ulmus may be due merely to fluctuations in the other arboreal genera .

Plantago major-media does not appear until several hundred years later, at the 236 cm , 234 cm and 232 cm horizons . All these clearances suggest exposed soil,and could indicate arable Neolithic agriculture . The first Ulmus clearances occur at the 232 cm horizon when there was a sharp fall in the genus .

At the Waun Fach site , one finds , that the Ulmus decline is accompanied by the appearance of Plantago lanceolata . Waun Fach Central represents an adjoining area of the Wye lowlands lying to the west (see section 6.110 & Fig. 6.110) . From similarities in both profiles , it is possible to date basal zone boundaries on Waun Fach Central using the Waun Fach South diagram (see Table 7.6) .

The Ulmus clearances and the Plantago sp. appearances between the years 5000 and 4300 b.p. are given in Table 6.110 ,in which the three Waun Fach profiles are compared .

TABLE 6.100

ULMUS CLEARANCES AND PLANTAGO SP. APPEARANCES BETWEEN 5000 & 4300 YEARS b.p.

Years b.p.	WAUN FACH SOUTH			WAUN FACH CENTRAL			WAUN FACH NORTH	
	Peat horizon cm	Years b.p.	Plantago sp. present*	Peat horizon cm	Years b.p.	Plantago sp. present*	peat horizon cm	years b.p.
4300	232	4360	P.m.m.				210	4350
							212	4430
4400	234	4450	P.m.m.				213	4480
4500	236	4500	P.m.m.	232 to	4490	P.l.	215	4560
4600				234	4570	P.l.	216	4600
4700				236 to 238	4660 4740	P.l. P.m.m. P.l.	220	4780
4800				240	4820	P.l.	221 223	4820 4900
4900				243	4950	P.l.	224	4953
5000							227	5080
	← Lowland Sites →					→	← Upland Sites → Upland valley	

* P.m.m. represents Plantago major - media .

P.l. represents Plantago lanceolata .

It can be seen from Table 6.100, that woodland clearances of Ulmus WERE RECORDED first on Waun Fach Central and later , on Waun Fach South . This suggests that , around 4500 years b.p. , the Neolithic peoples moved their activities over to the area represented by the Waun Fach South profile (see Figure 6.110 & section 7.4) .

The decline in Ulmus on the Waun Fach Central profile consists of two , relatively brief , clearance phases ,followed by two clearance phases , which are more extensive and longer duration .

The first extensive phase has extrapolated dates of 4740 to 4660 years b.p. It is the most severe clearance phase and involved the clearance of several genera in addition to Ulmus (see Figure 6.72) . This lowland clearance phase, covering perhaps several hectares (e.g. 2 - 10 hectares), , can be compared to the "Landnam" clearance, Iverson J. (1949). The second extensive phase, from 4570 to 4500 years b.p. was more specific and shorter.

Judging by the presence of Plantago lanceolata , the majority of the extensive phase clearances appear to be pastoral , although the appearance of Plantago major-media in the first extensive phase (between 4740 and 4650 years b.p.) suggests some arable activity . The building of long cairns and of settlements may also be contributary causes of clearances (see section 7.4 and Fig. 7.52).

From Table 6.100 it is plausible that clearance activity shifts from the areas represented on Waun Fach Central to the adjoining areas represented on Waun Fach South , which is believed to be a more westerly location in the Wye lowlands (see Figure 6.110) .

The clearances on Waun Fach South began about 2500 B.C. (4500 years b.p.), and lasted for perhaps 170 years. The approximate date of 2500 B.C. has been recorded as the beginning of a second Ulmus decline. A second Ulmus decline has been noted by other researchers including, Smith A.G. (1961 - 1962), Merryfield. D. & Moore. P.D. (1974), and Troels-Smith J. (1960).

On Waun Fach South the Plantago sp. is Plantago major - media. This suggests arable agriculture, Turner. J., (1965), and on open exposed ground, cleared for example, for cairn building (see Figure 7.52). A unique feature of the clearance on Waun Fach South is the inability of Ulmus to regenerate compeletely following clearance.

To conclude, the four clearance phases on Waun Fach Central commencing at about 5000 b.p. may be called the Ulmus decline. The Waun Fach South clearances may be regarded as the second Ulmus decline.

THE WAUN FACH NORTH PROFILE

The Ulmus decline on the Waun Fach North profile begins just above the 227 cm horizon with a sharp progressive fall in Ulmus T.A.P. from 30 to 17 % T.A.P., at the 224 cm horizon. A profusion of ruderals indicative of disturbance are also recorded over the same period, namely, Taraxacum type, Umbellifereae, Chenopodiaceae, Rosaceae, and Compositae. Ulmus completely regenerates at the 223 cm horizon followed by another sharp progressive decline in Ulmus, (see Table 6.100).

These limited selective clearances and Ulmus regeneration were repeated several times. If the basal date of the Ulmus decline is taken to be 5000 years b.p., then these numerous selective clearances extend to 4350 years b.p. These selective clearances, sometimes including Tilia, are thought to occur on the high upland slopes of the Grwyne Fawr valley.

THE CAUSES OF ULMUS DECLINE IN THE BLACK MOUNTAINS

(i) Climatic change :

Various factors have been suggested as causes for the *Ulmus* decline. Iversen , J. (1941,1944 and 1960) suggested that the *Ulmus* decline was a result of climatic change. He speculated that an increase in cold weather caused a reduction in the number of *Ulmus* accompanied by a decline in *Hedera* .

Godwin , H. (1956) , was of the opinion that the decline in *Ulmus* was due to the late spring frosts . This was rejected by Van Zeist , W. (1959) on the ground that *Fraxinus* is susceptible to late frosts and generally thrives when *Ulmus* declines . The dissimilar nature of the *Ulmus* declines on the Waun Fach Central and Waun Fach North profiles together with the probable 2nd *Ulmus* decline on the Waun Fach South profile circa 4500 years b.p. suggest, that,climate was not necessarily a causative agent during the *Ulmus* decline .

(ii) Soil deterioration :

Troels - Smith (1960) , suggested that soil deterioration was a possible cause of *Ulmus* decline . *Ulmus* likes basic soils , and could be prevented from regeneration by changes in soil pH . It is widely known that *Fraxinus* also favours more alkaline soils as Godwin verified in 1975 . In the Black Mountains , *Fraxinus* did not decline at the same time as *Ulmus* , and *Ulmus* regenerated , at least partly .

The recovery of *Ulmus* in Central Wales as noted by Moore , P.D. (1966) ; in the Lake District as observed by Oldfield , D. (1963) , all indicate that soil deterioration is not the causative factor in the *Ulmus* decline .

(iii) Disease

Disease , particularly Dutch Elm disease , has been put forward as a cause of Ulmus decline by Watts W.A. (1960) . The Ulmus decline recorded on Waun Fach appears to be a series of small selective clearances . The duration and nature of the clearances does vary between the Waun Fach Central and Waun Fach North profiles .

These facts , coupled , with the regeneration of Ulmus suggests, that disease could not have been the cause for the Ulmus decline . A recent publication by a plant pathologist , Heybroek H.M. (1963) , also confirms that , disease could not have been the cause for Ulmus decline .

Heybroek states , that , there is little historical evidence to support an ancient disease in Ulmus sp. . The widespread nature of Ulmus decline , also suggests that , disease is an unlikely candidate for Ulmus decline . The lack of resistance to the present Ulmus diseases , suggests that , disease is a relatively new phenomenon of this or perhaps the last century , Heybroek H.M. (1963) .

THE ANTHROPOGENIC FACTORS IN ULMUS DECLINE

Having excluded climate , soil deterioration and disease as possible causes of Ulmus decline in the Black Mountains , there remain the anthropogenic factors .

At a time when the Ulmus decline was generally considered to be due to climatic causes , Iversen in 1941 , attributed certain vegetational changes , which occurred immediately above the Ulmus decline , to deliberate forest clearance by Neolithic man . In such changes , limited patches of ground were prepared for primitive cereal cultivation by clearing all trees in patches .

In the Black Mountains the results as shown in the profiles do indicate that deliberate clearances of Ulmus by Neolithic man has taken place and has had a profound effect on the local vegetation . Such clearances have been probably not only for primitive cereal production but also to provide areas for grazing , Pennington , W. (1969) .

The introduction of grazing animals can have a marked effect on Ulmus growth . It is probable that early man in the Black Mountains region , followed the Neolithic practice of cutting Ulmus leaves and branches for fodder . This custom , as practiced in Central Europe , reduced the reproductive potential of the plant and flowering was impeded for ten years or more , Troels - Smith , (1960) .

Ulmus barking by cattle can cause damage and even tree death . This has been observed by Smith , A.G. (1979) , (personal communication) , in South Wales where extensive damages was inflicted on an Ulmus forest .

Both cattle and sheep readily eat fresh new Ulmus seedlings in a woodland. This , combined with the effects of trampling , can stop Ulmus regeneration altogether . Even to - day in the fenced Mynydd Ddu , primarily coniferous forests in the Black Mountains up to 50 % of planted seedlings are eaten by sheep , Lewis , T.H. (1978) , (personal communication with the head forester Lewis) .

In Walker's & TAYLOR study of Neolithic peoples in Cumbria (1976) , it is suggested that the ring barking of Ulmus trees was practised on thicker trees that could not be felled easily in Neolithic times . It was a convenient way of killing trees which may well have been used by Neolithic man in the Black Mountains (see section 7.4) .

On one field-trip to the Black Mountains in 1978 , it was actually seen , that a farmer , in the Grwyne Fawr valley was still pollarding trees for winter fodder for his sheep. This supports the idea that trees may have been used by the Neolithic man in the Black Mountains .

THE AREAS REPRESENTED ON THE FIVE BLACK MOUNTAINS PROFILES AND THE "POLLEN SHED THEORY"

6.110
The wind direction and the configuration of the mountain massif , with it's valleys , gullies and plateaux , are the deciding factors which determine from which area the pollen is gathered and where it will be deposited . Thus, with the Pen y Gader-Fawr ,the channelling of wind up the Llanbedr valley causes the air - borne pollen to be deposited on and around Pen y Gader - Fawr sampling site .

Similarly , with the Ty isaf site , it is the air movement up the Rhian goll valley which is responsible for the deposition of the majority of the pollen on the sampling site .

On the flat Waun Fach plateau , however , there are unexpected anomolies in pollen deposition . On the Waun Fach South and Central sites the pollen picture is completely different from that on the Waun Fach North site , which is only a few metres away . Furthermore , the pollen spectra differ , not only with present , surface,pollen but marked differences occur throughout the whole time span of some 5000 years between the Waun Fach North and the other two sites (Waun Fach South & Central).

It will be shown , in the details which follow , that a possible explanation for these differences in pollen spectra is provided by a " pollen shed " theory .

THE AREAS REPRESENTED ON THE FIVE PROFILES

6.111
The most probable areas , from which the majority of the pollen is derived , are defined for each sampling site . Each area is selected after detailed comparisons between the pollen spectra of the five pollen profiles at comparable

dates . In these comparisons , it is possible to find similarities and dissimilarities , and thus , by a process of elimination , to arrive at the most probable area for each site .

Since the geography of the area , the valleys , gullies , ridges and plateaux , have remained virtually unchanged for the past five thousand years , it is assumed that the defined areas have also remained essentially the same , as locations from which pollen is transported .

AREAS REPRESENTED ON THE PEN y GADER - FAWR PROFILE

6.112

This profile has several features which suggest that it represents an area not recorded on any of the other profiles . The particular features are : -

(1) There is one large and extensive clearance phase which reaches a peak at the 51 cm horizon (1750 extrapolated years b.p.) . The genera cleared and the high percentage T.A.P. for Plantago lanceolata and other ruderals , makes this clearance unique among the Black Mountain's profiles . There is no corresponding clearance phase of this size at this time , in any of the other profiles.

(2) At the base of the Pen y Gader - Fawr profile , at the 116 cm horizon , Betula pollen is completely absent . This suggests a total clearance of this genus in the area represented on the pollen profile . The absence of Betula is unique to this profile .

(3) Throughout the profile on this site , several families and genera such as Taraxacum type, Umbelliferae, and Rosaceae have much higher T.A.P. percentages than any of the other profiles.

(4) The T.A.P. percentages for Tilia decline to apparent extinction, a millenium after Tilia declined on the Waun Fach South and Central profiles and, about 800 years before Tilia on the Waun Fach North profile.

This suggests that the Tilia pollen recorded on the Waun Fach and Pen y Gader - Fawr sites came from at least three separate geographic locations.

(5) A special feature of the Pen y Gader - Fawr profile is the prominent Bronze age clearance phase with Plantago lanceolata which peaks between 83 cm and 79 cm horizons (2800 to 2700 extrapolated years b.p.).

There is no record, in the Waun Fach South, Waun Fach Central and Waun Fach North sites of such extensive clearances at this time or even within several centuries of this time. This strongly suggests that winds from westerly, northerly and easterly directions, which deposited pollen on the three Waun Fach sites, can be excluded as carriers of pollen to the Pen y Gader - Fawr site.

It follows therefore, that the pollen collected on the Pen y Gader - Fawr site must originate from a different area. In fact, the pollen sampling site is located above and overlooking the Llanbedr valley (see Fig. 6.110B). This valley has witnessed considerable human activity on its western boundry ridge where a string of Bronze age round barrows are located (see Figure 7.3).

It is concluded therefore, that the pollen spectra on Pen y Gader - Fawr records a separate area from the other Black Mountains sites. It is likely also that the pollen collected is from a fairly local area and that little or no regional pollen is arriving at the site (for example Betula is

Figures 6.110a* and 6.110b** .

The following Figures , 6.110a & 6.110b , indicate (shaded areas) possible areas which may be represented on the five pollen profiles . The bulk of pollen arriving at the five separate sample sites originated from these five (6 including overlap zone Waun Fach South / Waun Fach Central) areas .

The choice of these areas is based on interpretation of the fossil pollen of the five profiles , Waun Fach South, Waun Fach North , Waun Fach Central , Ty isaf and Pen y Gader-Fawr .

* 6.110a ; probable areas represented on Waun Fach South and Waun Fach Central .

** 6.110b ; probable areas represented on Waun Fach North , Ty isaf and Pen y Gader-Fawr .

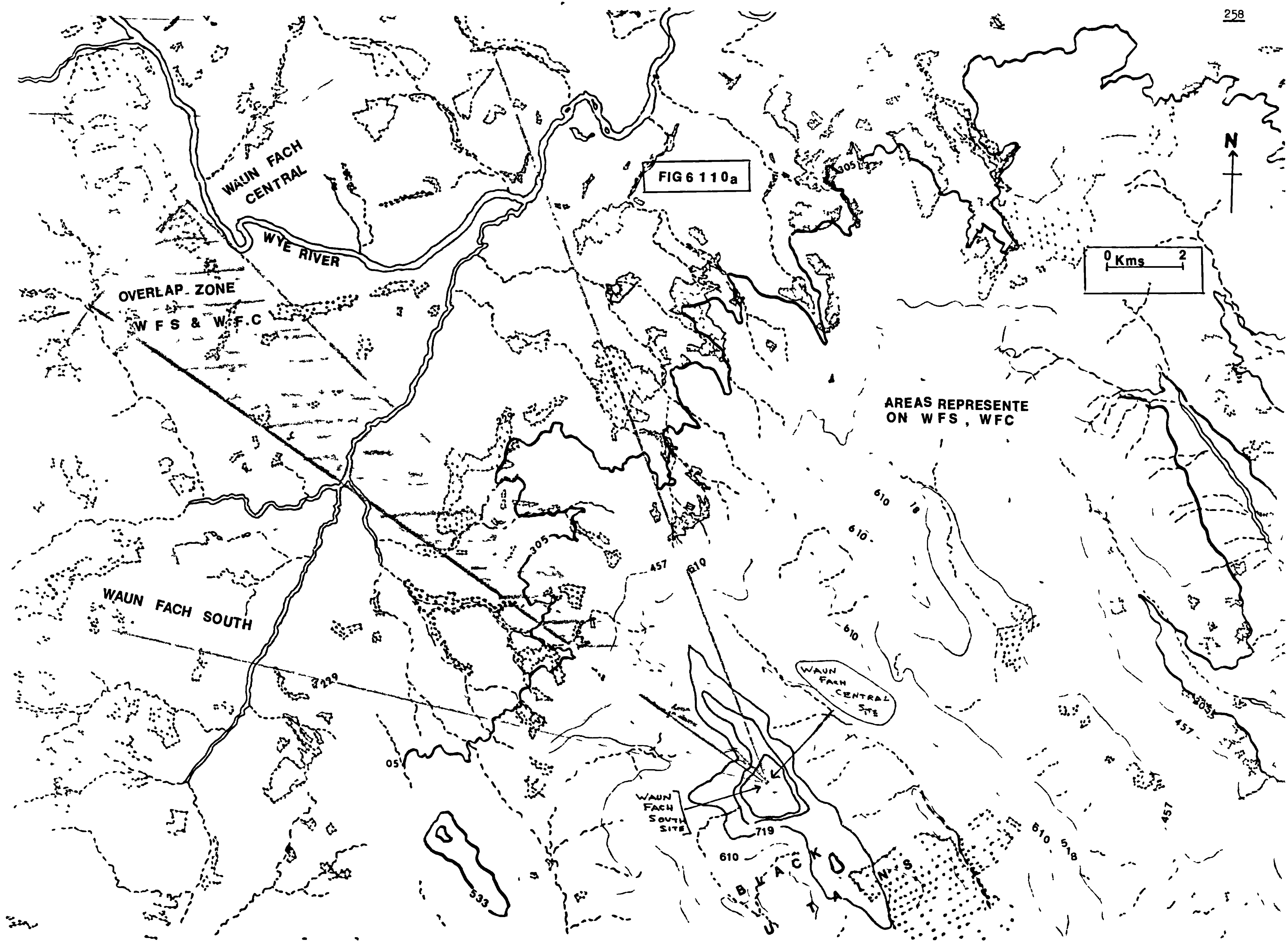


FIG 6 110a
N
0 Kms 2
WAUN FACH CENTRAL
WYE RIVER
OVERLAP ZONE
W F S & W F C
WAUN FACH SOUTH
AREAS REPRESENTE
ON W F S , W F C
WAUN FACH CENTRAL SITE
WAUN FACH SOUTH SITE
BLACK MOUNTAINS
305
457
610
719
533
518
229

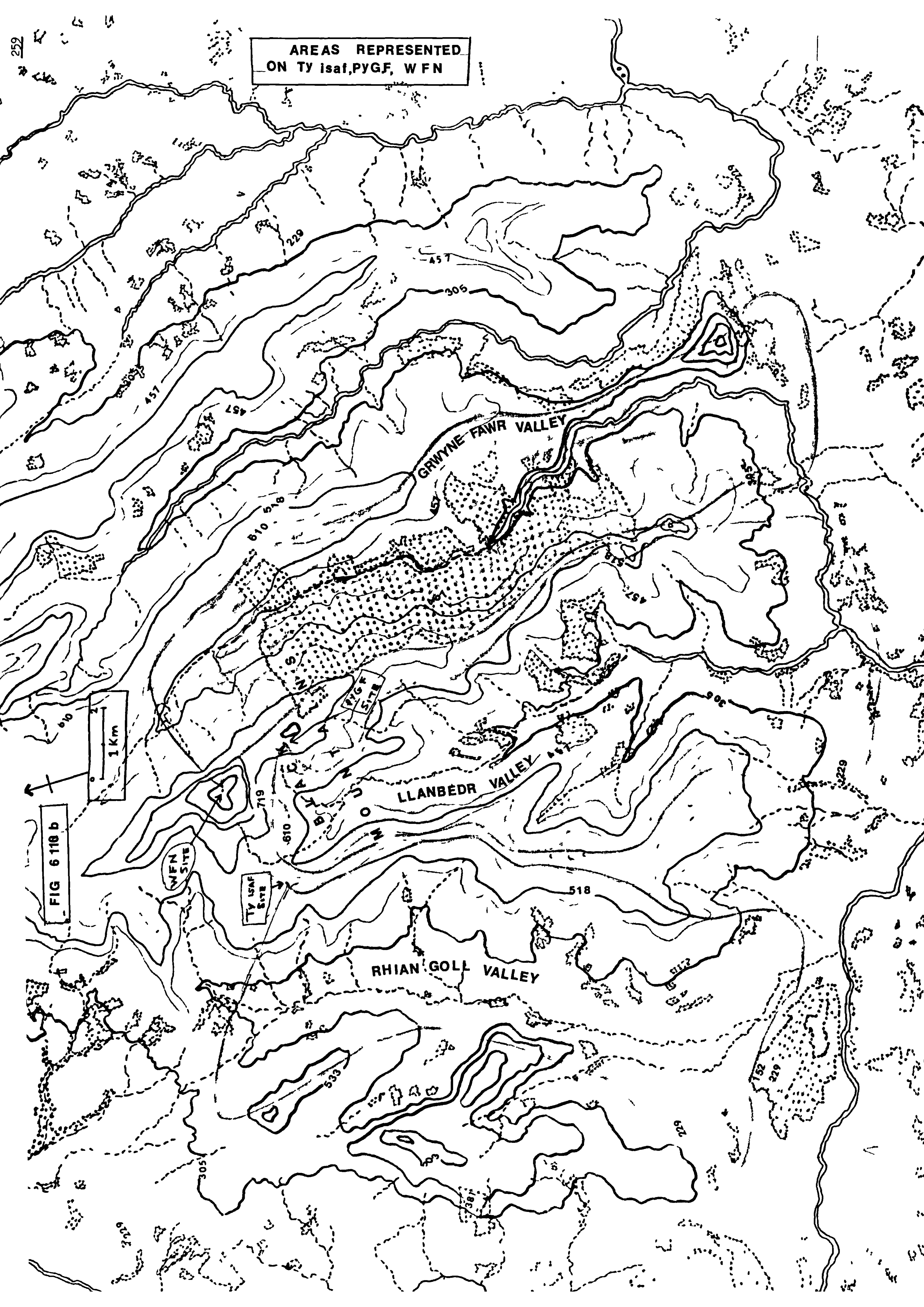

AREAS REPRESENTED
ON Ty isaf,PyG.F, WFN
GRWYNE FAWR VALLEY
LLANBEDR VALLEY
RHIAN GOLL VALLEY
BLACK MOUNTAINS
PyGF SITE
WFN SITE
Ty ISAF SITE
1 Km
457
305
229
610
518
719
533
381
152

FIG 6 11B b

absent at the 116 cm horizon , see section 6.61) .

The area from which most of the pollen comes is most probably the Llanbedr valley . Wind bearing pollen is channeled up this valley and the pollen is deposited on the sample site . On several field trips to this area , winds have been observed blowing up Llanbedr valley . It is probable that the Pen y Gader - Fawr profile reflects mainly the floristic changes which have taken place in the Llanbedr valley from the time of peat initiation .

AREAS REPRESENTED IN THE TY ISAF POLLEN PROFILE

6.113
This pollen profile is the youngest of the radio - carbon dated profiles (2345 years b.p.) , and is discussed in section 5.52 . It is the most westerly of the pollen sites and overlooks the Rhian goll valley . Some unique features of this profile are given below : -

(1) On the 35 cm to 31 cm horizon :

There is a very severe localised clearance phase which lasted from about 1069 to 950 radio-carbon years b.p. (extrapolated date). Plantago lanceolata, during the peak of clearance activity , reached 149 % T.A.P. The same time period on the other pollen profiles is marked by a period of low clearance activity .

This suggests that the clearances recorded on Ty isaf are local and that this site is receiving pollen from a local source , different from all other site sources . The most probable local source is the Rhian goll valley . Once again wind is channelled up this valley and pollen is deposited around the Ty isaf site (see Fig. 6.110B) .

(2) Clearance phases on the other four Black Mountains sites do not synchronise with those recorded in the Ty isaf profile , even allowing for large errors in dating . This suggests that the other four profiles are not recording clearances in the Rhian goll valley .

The Rhian goll valley has a remarkable number of archaeological sites ranging from the Neolithic and Bronze ages to the Iron age - Roman period . Land use in the valley continued through the Norman conquest right up to modern times . It is highly probable that the Ty isaf profile has received most of its pollen from the Rhian goll valley .

AREAS REPRESENTED ON THE WAUN FACH POLLEN SITES

(A) THE WAUN FACH SOUTH AND CENTRAL PROFILES :

6.114 These two fossil profiles , which are discussed in sections 6.7 & 6.8. exhibit many similar periods of floristic changes . There is however , evidence which suggests that profiles do not represent exactly the same areas . For example ,

(1) At the base of the Waun Fach Centre profile there is an intensive clearance phase peaking between the 239 cm and 237 cm horizons. This clearance phase , which caused a dramatic fall in the percentages of T.A.P. for most tree genera is unique to this profile . This suggests that certain areas represented on Waun Fach Centre are not represented on Waun Fach South nor on any other Black Mountains profiles .

(2) The Waun Fach South profile recorded high T.A.P. percentages for *Fraxinus* during two separate periods (3600 to 3200 , and 360 to 100 radiocarbon extrapolated years b.p.)..The Waun Fach Centre profile has much lower *Fraxinus* T.A.P. at these sites .

(3) The Waun Fach Centre profile often records clearances at different dates to Waun Fach South and Waun Fach North (see Figures 6.8 & 6.9) .

(4) The Waun Fach Centre profile has generally higher T.A.P. percentages for *Plantago lanceolata* and *Plantago major - media* . However , on Waun Fach South the percentage T.A.P. for *Plantago* sp. at the 120 and 125 cm horizons were higher than that of Waun Fach Central profile

The evidence given in the four points above together with the evidence given in the discussion sections 6.7 and 6.8 suggest the following : -

(1) That both profiles represent two , probably adjoining areas which overlap slightly .

(2) The zone of overlap is represented by similarities which exist between the pollen spectra of both profiles.

(3) The separate areas are represented by sharp differences in the T.A.P. percentages for the same genera over several horizons .

The problem remains , which areas do Waun Fach South and Waun Fach Central represent ? We can eliminate the Llanbedr valley to the south and south-east and the Rhian goll valley to the south and south-west , since , there are restricted wind channels discharging pollen on the Pen y Gader-Fawr and Ty isaf sites respectively .

We can also eliminate the narrow Grwyne Fawr valley to the east and south-east , on the Waun Fach North site . The area due north is eliminated since any pollen bearing wind from that direction would have contributed to the Waun Fach North profile and there is no contribution since the area supplying the Waun Fach North profile exclusively is Grwyne Fawr valley (see Fig. 6.110a).

There only remains the extensive open areas to the west and north-west extending out over the Wye lowlands south of the Wye river . It is significant that the prevailing westerly winds blow over these Wye lowlands towards the Waun Fach plateau .

It is deduced from the fossil pollen data in the Waun Fach South and Central profiles , that the wide area which includes portions of the Wye lowlands , can be divided into three fan-shaped zones as follows : -

(i) A north-west zone which is represented solely on the Waun Fach Central site .

(ii) A due west north - west zone which is represented solely on the Waun Fach South site .

(iii) An overlap zone between (i) and (ii) which is represented on both sites .

These zones are illustrated in Figure 6.110A .

(B) THE WAUN FACH NORTH PROFILE

6.115

In striking contrast to the Waun Fach Centre and South profiles , the Waun Fach North profile appears to represent an area, almost untouched by clearance throughout most of its history . From Figure 6.91 , it will be seen that the Waun Fach North profile is unique and remarkable for the following reasons : -

(1) The Waun Fach North profile records fewer and less severe clearances than any of the Black Mountains profiles . There are however long periods with no clearance activity.

(2) The Waun Fach North profile records the highest *Ulmus* T.A.P. percentages in any profile (up to 40 % of T.A.P.) .

(3) *Ulmus* is represented on every horizon examined . This is not true of any other Black Mountains profile .

(4) *Fraxinus* is never a prominent arboreal genus in the Waun Fach North profile . This contrasts with the *Fraxinus* records in the other Waun Fach profiles and in the Ty isaf profile .

(5) Betula T.A.P. percentages are generally lower on Waun Fach North than on any other profile . This is indicative of less disturbance , Moore P.D. and Bellamy, D.J. (1974) .

(6) No cereal pollen is registered in the Waun Fach North profile unlike the other Black Mountains profiles .

(7) The T.A.P. percentages for Tilia and Ulmus decline much later on Waun Fach North than on any of the other profiles .

(8) The high incidence of coniferous pollen recorded on the Waun Fach North No 5 surface pollen site and on the five extra Waun Fach surface sites (Nos. 1 to 10 inclusive), is of particular significance . It provides strong evidence that the wind , which impinges on these sites , passes through and over the Mynydd Ddu forest and therefore it passes up the Grwyne Fawr valley .

To sum up ; it is concluded, from the above evidence, from the evidence of surface pollen data (section 3.24) , and from the discussion in section 6.9 , that : -

(A) That Waun Fach North sampling site represents a completely different area from those represented on the Waun Fach South , Waun Fach Centre , Ty isaf and Pen y Gader-Fawr .

(B) The area represented on the Waun Fach North site has been relatively untouched and there is little clearance activity recorded in the bottom two thirds of the profile . Such conditions are most likely to be found in a restricted area such as an isolated valley .

(C) The Grwyne Fawr valley , to the east of Waun Fach North site, is the logical area which is wholly or partly represented in the profile . The area lies in a steep and narrow valley deep in the heart of the Black Mountains .

The valley has low arable and pastoral potential . There is only one archaeological site , situated at the far end of the valley . This is the Iron age hill fort , Twyn - y - Gaer (see Fig. 7.21) .

Today the valley contains the Mynydd Ddu forest reserve which is the undoubted area from which coniferous surface pollen is transported to the sampling site . As with the other valleys , the wind is channelled up the narrow valley to emerge into the locality of the Waun Fach North site , where pollen is deposited .

It is unlikely that any significant amount of pollen blowing in from the north contributes to the Waun Fach North pollen spectra. Betula T.A.P. on Waun Fach North was very low compared to T.A.P. for Betula on Waun Fach South and Waun Fach Central . If there had been large amounts of pollen from the north, then , the Betula T.A.P. would be significantly higher . This is because the areas to the north of Waun Fach North , are mainly lowlands , and , would have a similar proportion of Betula as other lowland areas (as represented on Waun Fach South and Waun Fach Central) .

THE POLLEN SHED THEORY

6.116

As mentioned in section 6.114-5, there are unexpected anomolies in pollen deposition on the Waun Fach plateau . The pollen assemblages collected at the South and Central sites differ in a dramatic way from the pollen spectra of the North site .

It has been shown that the North site is receiving the bulk of its pollen from the Grwyne Fawr valley to the east while the South and Central sites are receiving their pollen from the Wye lowlands to the west and north-west . This means that the westerly winds dump their pollen on the South and Central sites but not on the North site only 50 metres away , (see Figure 6.106) .

Conversely easterly pollen laden winds deposits its pollen on the North site but not on the neighbouring South and Central sites .

The probable mechanics of pollen deposition is best illustrated on the Waun Fach plateau. Figure 6.106 , is an elevation profile of this plateau . When westerly , pollen - bearing wind strikes the western lip or leading edge of the plateau , eddies are produced which bring the pollen down to the plateau surface (see Figure 6.107) .

Here deposition takes place in the still air , which forms a thin layer , just above the soil surface , Gregory P . H . (1945) , describes a similar phenomenon in his paper on the dispersion of air - borne spores . This phenomenon is very much like a wave breaking on a beach and depositing its load of suspended sand . The part played by wind eddies in transporting pollen has also been described by Sutton O.G. , (1932) and by Crampton C.B. , (1966) .

From the results obtained on Waun Fach , it is probable that the precipitation of pollen from eddies is confined to a limited distance from the leading edge

FIG 6 106

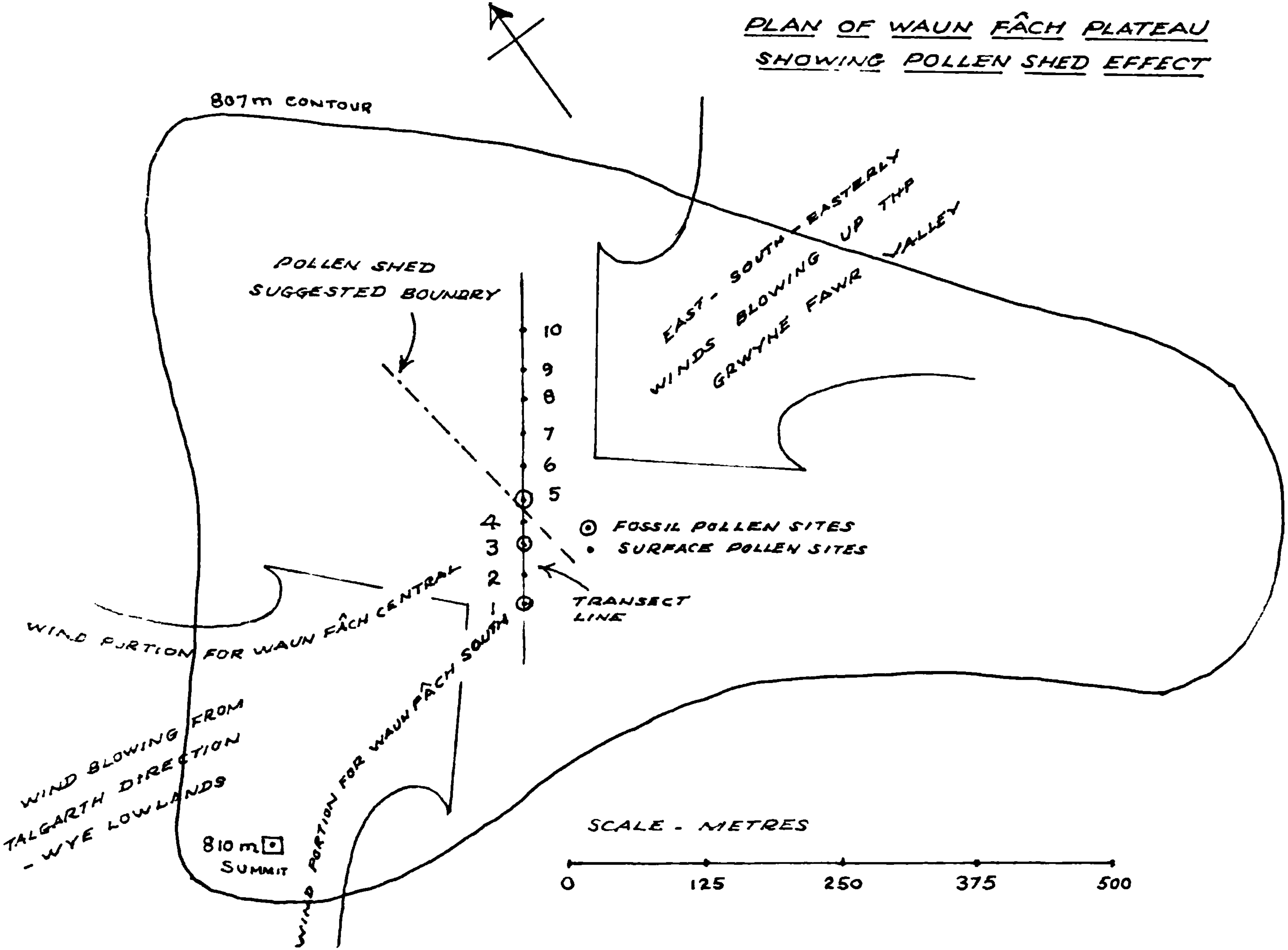
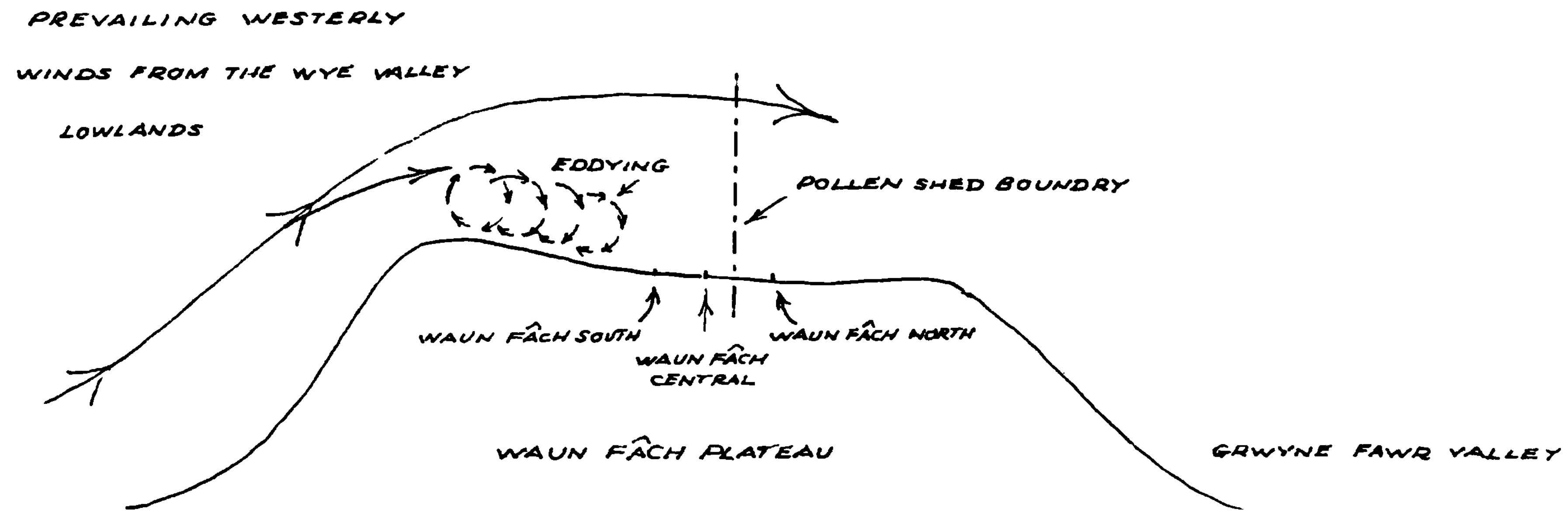
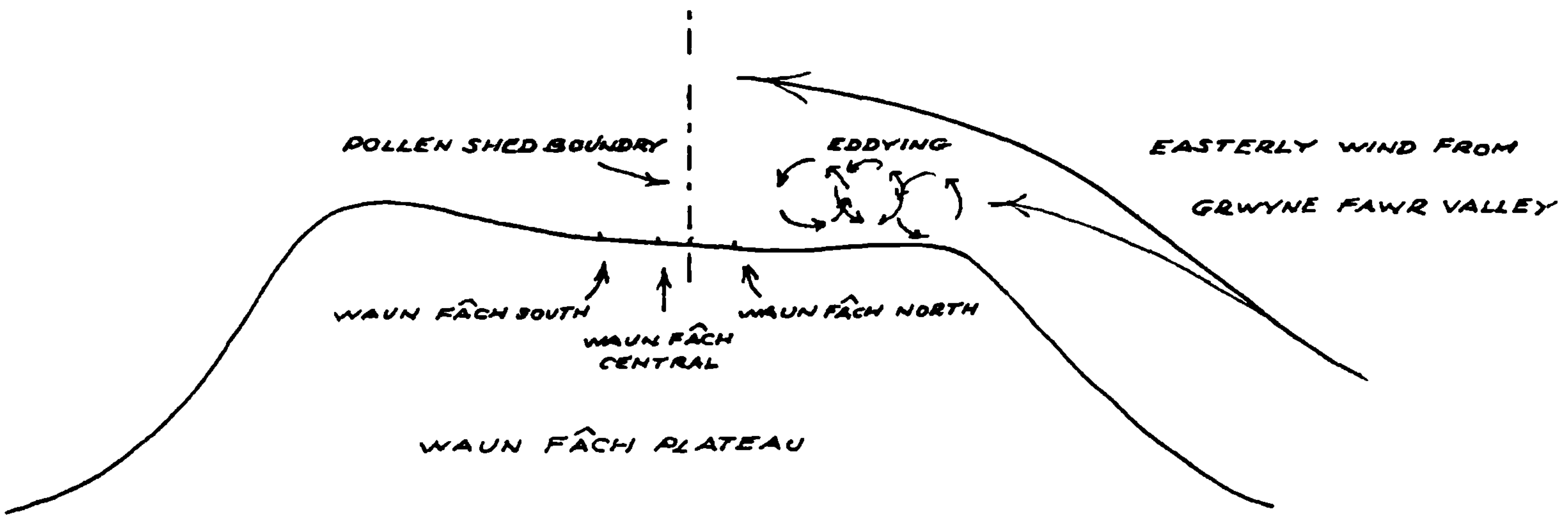

PLAN OF WAUN FÂCH PLATEAU
SHOWING POLLEN SHED EFFECT
N
807m CONTOUR
POLLEN SHED
SUGGESTED BOUNDRY
EAST - SOUTH - EASTERLY
WINDS BLOWING UP THE
GRWYNE FAWR VALLEY
10
9
8
7
6
5
4
3
2
1
FOSSIL POLLEN SITES
SURFACE POLLEN SITES
TRANSECT LINE
WIND PORTION FOR WAUN FÂCH CENTRAL
WIND PORTION FOR WAUN FÂCH SOUTH
WIND BLOWING FROM
TALGARTH DIRECTION
- WYE LOWLANDS
810m SUMMIT
SCALE - METRES
0
125
250
375
500

FIG 6 107



DIAGRAMATIC ELEVATION OF WAUN FÂCH PLATEAU - SHOWING WESTERN POLLEN SHED AND EDDYING AND DEPOSITION OF SUSPENDED POLLEN FROM WESTERLY WIND

FIG. 6 108



DIAGRAMATIC ELEVATION OF WAUN FACH PLATEAU - SHOWING EASTERN POLLEN SHED AND EDDYING WITH DEPOSITION OF SUSPENDED POLLEN FROM EASTERLY WIND of the plateau . In other words , the eddies " break " or dump their pollen before they can travel very far . It is probably for this reason that eddies , produced at the western lip of the plateau , do not travel as far as the Waun Fach North site .

In a similar fashion , the wind blowing up the Grwyne Fawr valley produces eddies on striking the eastern edge of the plateau (see Figure 6.108) . These eddies unload their pollen on the Waun Fach North site and on the five new surface pollen sites at the north-east end of the transect . The south-western end of the transect receives virtually no pollen from this eddy source .

The two sets of eddies each appear to stop at a boundary which marks the limits of the pollen shed from west and east . This pollen shed boundary separates the Waun Fach South and Centre sites from Waun Fach North and from the extra five surface pollen sites , Waun Fach 6 to 10 inclusive .

There may be occasional slight " overspill " on either side of the pollen shed , but , nevertheless, the boundary is real as is evinced by both the fossil and surface pollen results .

It is most probable that a similar phenomenon of air eddying and deposition of pollen occurs on both the Pen y Gader-Fawr and Ty isaf pollen sampling sites .

TABLE 6.120

A COMPARISON OF PLANTAGO LANCEOLATA, CEREALS T.A.P. PERCENTAGES IN SURFACE POLLEN AND IN FOSSIL POLLEN HORIZONS

	Surface pollen		Fossil pollen			
	Plantago.l % T.A.P.	Cereals % T.A.P	Plantago.l % T.A.P.	Cereals % T.A.P	Peat depth in cm	Extrapolated years b.p.
Ty isaf	32	6	29	10	19	580
			32	10	29	890
			23	4	58	1770
P.Y.G.F.	30	4	26	4	46	1570
			35	4	51	1750
			27	0	83	2800
W.F.S.	20	4	22	5	105	1700
			21	5	115	1800
W.F.C.	20	6	19	0	35	660
			20	3	95	1700
			18	5	115	1900
			18	5	135	2130
			22	0	158	2430
W.F.N.	8	2	8	0	30	480
			8	0	65	1260
			9	0	100	1830

Note : Plantago .l represents Plantago lanceolata .

In Table 6.120 surface pollen counts for *Plantago lanceolata* are compared with counts obtained on fossil pollen horizons . The fossil pollen horizons listed are those which have similar *Plantago lanceolata* T.A.P. percentages. Cereal T.A.P. percentages are added for further comparisons. these somewhat rough comparisons are of necessity , approximate only .

A ROUGH COMPARISON OF SURFACE POLLEN DATA WITH FOSSIL POLLEN DATA

From Table 6.120 it will be seen , that , in all five fossil profiles selected , the *Plantago lanceolata* percentages of T.A.P. counts are similar to those on the surface pollen sites . It will be seen also , that , the time period 1750 to 1850 extrapolated years b.p. is common to all five profiles .

This period is Iron age / Roman , when activity was intense and there were extensive settlements of Silures around the hill forts of the valleys and lowlands . Merryfield , on his Exmoor site , came to the same conclusion ; that present day clearance activities are similar to those of the Iron age , Merryfield D.L. (Ph.D thesis , 1977) .

With the knowledge that surface pollen data has some similar characteristics to clearances during the Iron age , it is then possible to use these criteria in evaluating Black Mountains fossil pollen data . This knowledge also reinforces the degree of caution needed when interpreting fossil pollen data .

PEAT INITIATION ON THE BLACK MOUNTAINS

6.130

The dates for peat initiation of the Black Mountains profiles were obtained by extrapolation from the radio - carbon dates from three profiles as follows : -

(1) Waun Fach South profile .

The deepest - dated sample in the profile was the 243 cm horizon with a radio - carbon date of 4830 $\pm$ 55 years b.p. (uncorrected) . The extrapolated date of peat at the basal horizon of 250 cm was 5100 years b.p. (see Figure 5.3). The basal 3 cm of Waun Fach North profile , suggest an even earlier initiation on this plateau (see section 7.02) .

(2) Pen y Gader - Fawr profile .

The 105 cm horizon was radio - carbon dated at 3525 $\pm$ 110 years b.p. (uncorrected) . This gave an extrapolated date for the basal peat horizon at 116 cm of 3876 years b.p. (see Figure 5.2) .

(3) Ty isaf profile (on Pen Trumau) .

Charcoal directly underlying peat had a radio - carbon date of 2345 $\pm$ 70 years b.p. (uncorrected) , and this must be regarded as immediatly prior to the date of peat initiation at this site (see Figure 5.1) .

There are many factors which may have been responsible for peat initiation on the Black Mountains . A change of climate for example , with cooler temperatures and greater precipitation , could have adversely affected the pre-peat vegetation . This could have led to soil leaching and increased water run - off . Anthropogenic factors also could have triggered peat initiation .

Evidence for Man's presence in the area during peat initiation are as follows -

(A) PEAT INITIATION ON WAUN FACH

6.131

Peat initiation dates for the Black Mountain's profiles suggest that peat initiation started first in the Waun Fach summit . This seems reasonable because conditions were such , that fewer hydrological changes were required to induce peat initiation . In other words , the ecosystem at the summit was already stressed .

The site has the highest altitude , the greatest precipitation and probably the coolest tempreatures of all the Black Mountain's sites . In addition , the Waun Fach sites are situated on a plateau which consists of a large shallow basin , well situated for retaining water and is thus more likely to become water-logged .

Peat initiation on Waun Fach South has an extrapolated date of 5127 years b.p. (see section 5.4 , Figure , 5.3) . The presence of the Boreal / Atlantic transition (i.e. increasing <u>Alnus</u> with decreasing <u>Pinus</u> T.A.P.) , (see Figure 6.91), in mor humus at the base of the Waun - Fach North profile suggests a slow growing mor humus layer prior to peat initiation proper .

HUMAN ACTIVITY IN THE AREA AT THE SAME TIME AS PEAT INITIATION

It is quite possible that anthropogenic causes may have been partly or wholey responsible for peat initiation on Waun Fach,and on the other two sample sites on Pen y Gader-Fawr and Ty isaf. However, in this study , the following evidence suggests mans presence in the area at the time of peat initiation .

(i) Firstly , in the basal layers of all three Waun Fach sample sites , there are records of substantial numbers of ruderals , which indicate local floristic disturbances . These disturbances very probably commenced prior to peat initiation, (see sections 6.7 ; 6.8 & 6.9) .

(ii) The presence of Plantago major - media near the base of the Waun Fach South profile (Figure 6.81) , and Plantago lanceolata (during a clearance phase) at the base of the Waun Fach Central profile (Figure 6.71), suggests human activity at the time of peat initiation.

(iii) The discovery of an imported Neolithic chert adze on the adjoining mountain , Pen y Gader-Fawr , the finding of numerous imported flint and chert fragments of Neolithic and Bronze age, on the same mountain , all suggest the presence of man , equipped with wood-cutting implements (see section 4.3) in the general area .

(iv) The extensive Neolithic long cairn and settlement sites to the north , south and west of the Black Mountains , suggest a significant Neolithic presence in the area (see Figure 7.52) .

(v) The profusion of bones of grazing animals , found in at least two long cairns suggest that grazing animals were present in the general area . If present land use is any guide such animals could have grazed on upland sites . Such grazing could adversly affect arboreal regeneration .

In addition , the Neolithic peoples could have cleared woodlands or portions of woodlands by direct felling and/or by girdling, Pennington W. (1969) , Smith A.G. (1979) . This practice of girdling has been discovered on other Neolithic sites , Smith , A.G. (1979) .

From the above evidence it is not possible to categorically state that peat initiation on Waun Fach was anthropogenic, but merely to say , that , there is a correlation between the timing of peat initiation and man's presence in the area .

(B) PEAT INITIATION ON PEN Y GADER-FAWR

6.132
This profile has an extrapolated date of 3876 years b.p. This date places peat initiation in the late Neolithic or early Bronze age. The profusion of cutting implements mentioned in the preceding paragraphs (section 5.41) and in section 4.3 , together with <u>Quercus</u> and <u>Betula</u> wood remains , found underlying peat only 150 metres from the Pen y Gader-Fawr site , strongly suggest a woodland , which had been felled prior to peat initiation .

It is reasonable to understand why peat initiation occured later on this summit than on Waun Fach . The elevation of Pen y Gader - Fawr is 38 metres lower , precipitation is probably less and the temperature slightly warmer than on Waun Fach summit .

Furthermore , instead of a shallow basin - type plateau , the Pen y Gader - Fawr site is located on steeper sloping ground with better drainage and less water retention .

The palynological evidence from the site profile and the archaeological evidence found in the vicinity, suggest that,repeated clearances probably occured both in the Neolithic period and in the Bronze age. The human activity on the summit could have been beneficial in providing conditions conducive to peat initiation. However all that can be said, is that, there is a correlation between human activity and the timing of peat initiation .

(C) PEAT INITIATION ON TY ISAF

6.133
The Ty isaf site is located on a western spur of Waun Fach . Here the charcoal layer underlying the peat monolith was radio-carbon dated at 2345 $\pm$ 75 years b.p. The existance of this carbon layer suggests that fire preceded peat initiation .

Historically the radio-carbon date encompasses the Iron age. Castel Dinas (one of numerous hill forts in the Black Mountains area) is located only 1.5 kilometres from the Ty isaf site. This fort is considered to be of a similar age to the Twyn y Gaer hill fort in Monmouthshire. Twgn y Gaer was radio-carbon dated at between 2330 and 2430 years b.p. , Savory H.N. (1950) . This suggests that Castel Dinas is approximately the same age as the charcoal layer.

It is therefore conceivable that, the Silures peoples cleared the Ty isaf area by burning . There is therefore , a correlation between human activity and the timing of peat initiation .

CHAPTER 7

COMPARISON AND CORRELATION OF ALL FIVE BLACK MOUNTAIN PROFILES

The following sections are groupings of chronologically similar periods in the five pollen profiles . It is hoped that meaningful comparisons may be made to understand more of the historical and pre-historical vegetational history of the area . From these comparisons it is possible to get quite a detailed picture of man's activities on and around the Black Mountains .

The five Black Mountain profiles are grouped into four chronological periods as follows : -

Period	Radio-carbon extrapolated years b.p.
Period D	circa 5100 to 3000
Period C	3000 to 2350
Period B	2350 to 1500
Period A	1500 to 100

TABLE 7.5 . POLLEN ZONES OF THE FIVE BLACK MOUNTAINS PROFILES .

	Waun Fach Central Yrs. b.p.	cm.	Waun Fach South Yrs. b.p.	cm.	Waun Fach North Yrs. b.p.	cm.	Pen y Gader - Fawr Yrs. b.p.	cm.	Ty isaf Yrs. b.p	cm.
	100	5	100	6						
	C10		S10							
									300	10
	360	20	360	22						
									T 5	
					480	30	480	14		
									550	18
	C 9		S 9							
					N 8					
							P 5			
									T 4	
	650	45	650	40	650	40				
							754	22		
A	C 8		S 8		N 7				764	25
							P 4		T 3	
	1150	60	1150	70	1150	60				
									1160	38
							1160	34		
	C 7		S 7		N 6				T 2	
	1480	75	1480	90	1480	75				
									1500	49
			<u>1550</u>	<u>94</u>			P 3			
	C6b		S6b							
									T 1	
	2130	135	2130	140						
					N 5				<u>2140</u>	<u>70</u>
B							2160	65		
									2186	72
	C6a		S6a							
									<u>2345</u>	<u>78</u>
	2370	150	2369	159	2369	135				
							<u>2535</u>	74		
	C5b		S5b							
							P 2			
	2545	174	2545	173						
C					N 4					
	C5a		S5a							
			<u>2835</u>	<u>196</u>						
	3050	194	3050	201	3050	180				
							3365	100		
							<u>3525</u>	<u>105</u>		
	C 4		S 4							
							P 1			
	3599	219	3600	214						
					N 3					
	C 3		S 3							
							3876	116		
	4150	226	4150	227						
					4380	210				
D	C 2		S 2							
	4450	231	4450	235						
					N 2					
			<u>4830</u>	<u>243</u>						
	C 1		S 1							
	5100	244	5100	250	5100	228				
					N 1					
					?	230				

NOTE : Underlined numbers represent uncorrected radio-carbon dates and depths .

PERIOD D

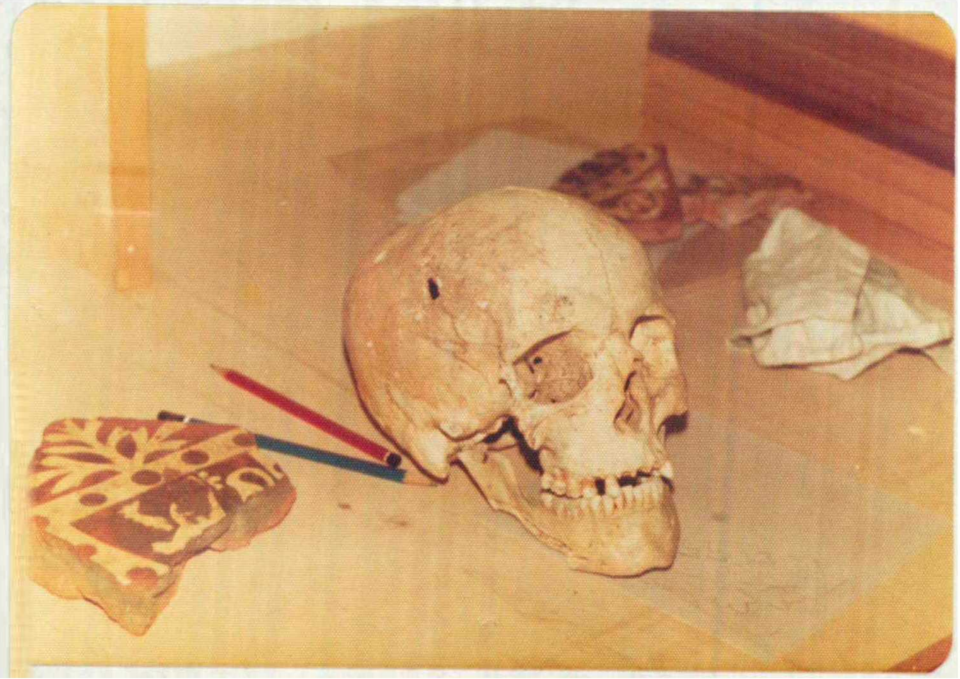
COMPARISON AND CORRELATION OF FOUR OF THE BLACK MOUNTAINS PROFILES BETWEEN 5100 TO 3000 EXTRAPOLATED YEARS b.p.

These profiles are represented on the following horizons .

7.4

Site	Peat depth in cms.	Radio-carbon years b.p. extrapolated
Waun Fach South	250 to 201 cm	5100 to 3000
Waun Fach Central	244 to 194 cm	5100 to 3000
Waun Fach North	227 to 180 cm	5100 to 3000
Pen y Gader-Fawr	116 to 87 cm	3800 to 3000

Plate 7.0



skull of a young Neolithic woman, 5000 years b.p. From the Pen y Wyrlod long Cairn near Talgarth (now in Cardiff Museum) .

PERIOD D

This period in time is represented in the three Waun Fach profiles and in the later stages by the Pen y Gader - Fawr profile . It extends in time probably at the Atlantic - Sub Boreal transition* circa 5100 years b.p. which is represented on the Waun Fach North profile (5100 , extrapolated years B.P. representing peat initiation on Waun Fach South) , and extending up to 3000 extrapolated years b.p., a common zone boundary for the Waun Fach profiles (see Figures 6.7 to 6.9 inclusive).

Human activity has been radio-carbon dated back to at least 5000 years b.p. from Neolithic Pen-y-Wyrlod long barrow, Savory H.N. (1973) and Ty isaf long barrow, Grimes, W.F. (1939) and possibly as far back as the late upper Palaeolithic period, Green , S. (1979),(see Table 7.4) .

In order to understand these early people more fully, a short digression into their origins & way of life will aid in the interpretation of palynological evidence obtained from the Waun Fach and Pen y Gader - Fawr profiles and of land usage at this time .

The only surviving structures of these Neolithic people are the chambered tombs or long barrows (Cairns). The structure of the long cairn is basically an oval earthen mound ranging from 16m. to 18m. long & 10m. to 35m. wide, containing several stone chambers in which the dead were placed and often surrounded by possessions (Figures 7.42 - 49 & 7.52) .

Structurally the Black Mountains long barrows are related to the Cotswold-severn types (Figs. 7.54-55), all of which are believed to be derived from their French ancestors in north-western France,(Fig. 7.4), and distributed along the coast. It is suggested by Savory H.N. (1978), and Daniel G.E. (1939), that these people migrated to England and Wales via the Bristol Channel . Close studies of the Figures 7.54 and 7.55 , shows

* Zone VIIa / VIIb , Godwin , H. (1940).

TABLE 7.4 , SOME ARCHAEOLOGICAL ARTIFACTS FROM THE BLACK MOUNTAINS , SOUTH WALES

Long cairn or site	C_{14}	Evidence of forest clearance	Evidence of hunting	Cairn size	Evidence of pastoralism	pollen profiles	Evidence of arable agriculture	Evidence of trade	Altitude	Soil underlying cairn	Orientation of cairn	pre - cairn vegetation	prior or latter use of cairn site	Evidence of settlement	Human remains No of persons	Source
Ty isaf*		Polished stones, axe & knife	Flint, arrow-heads, polcat, pig & mole ?	36 X 17 m	Sheep/goat dog ; ox .	Ty isaf		Pottery, C.W. & Cotswolds Gower; stone discs , flints	230 m.	Loamy , freely drained		Damp wood	Roman coin Round - barrow Beaker		33	Grimes 1939
CWM * Fforest						Ty isaf			230 m.							Grimes Wheeler Crawford 1939
Mynydd* Troed		Flint / chert fragments	Pig, flint fragments	27 X 17 m	ox			Cherts flints	357 m.	Loamy, freely drained	N E - S W	Mixed oak				Webley 1966
Gwernvale *	4900 , 2500 3050 B.C.	Flint , axe		45 X 4 m		P.Y.G.F. ?	Emmer wheat, Querns	Peterborough, flint pottery, sandstone discs	70 m.			Damp open wood	Mesolithic C_{14} 4900 B.C.	Yes		Britnell 1979
Pen - y - Wyrlod *	3020 B.C.		Fox, arrowhead flint knief	60 X 25 m		W.F.S			229 m.		N W - S E				12 +	Savory 1974
Ffostyll* south		Flint fragments	Flint fragments	36 X 22 m		W.F.C.		Flints	300 m.				Round barrow		9 +	Vulliamy 1921-23
Ffostyll* north				45 X 25 m		W.F.C.			300 m.		E - W		Round barrow			Vulliamy 1921-23
Pipton*				30 X 20 m		W.F.C.			90 m.	Loamy, freely drained		Oak, hazel wood				Savory 1956
Rhos Fach*						W.F.C. W.F.S.			327 m.							Webley Grimes 1966
Little lodge						W.F.C.			110 m.							Vulliamy 1921-23
Three cocks						W.F.C.			130 m.					Yes		Savory 1978,P.C.
Glasbury Wye river			Arrowheads axes						90 m.							Savory 1980
Mountain Pen y Gader-Fawr		Stone axe 60 flint & chert fragments	Polished stone axe			W.F. N			800 m.							Wheeler 1925
Hay Bluff *											N - S					Grimes 19 , P.C.

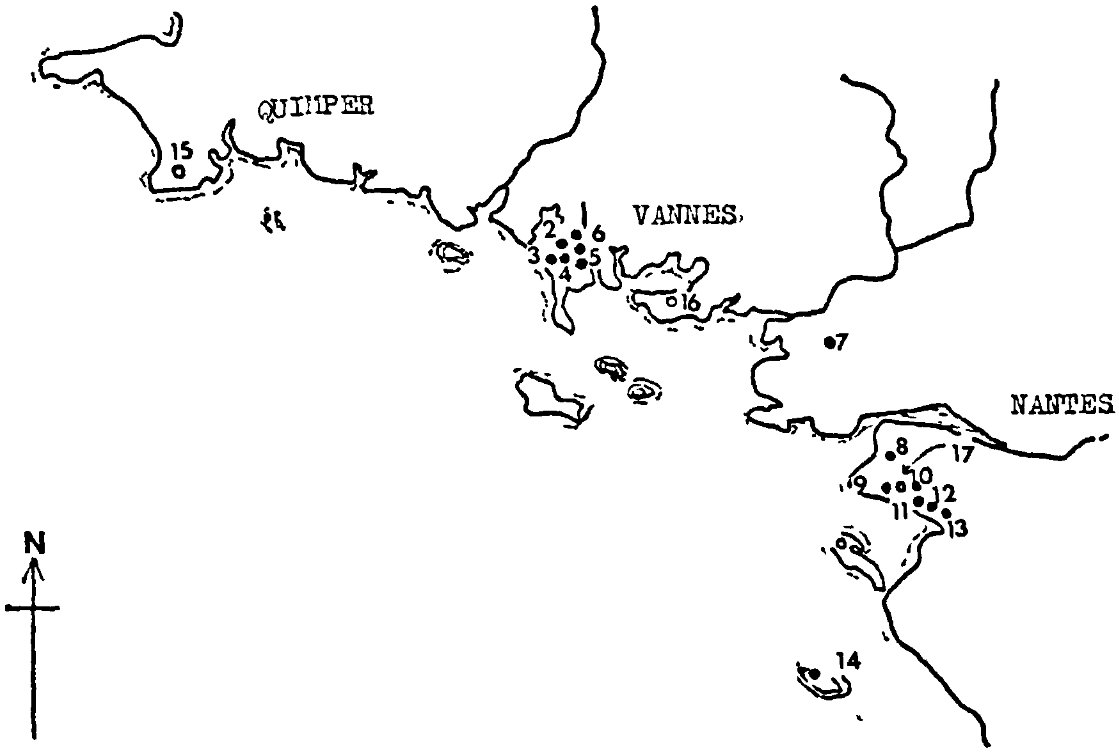
C.W. ; Central Wales
N W ; North west
S E ; South east
* ; Long cairn

the similarity between the Black Mountains cairns and the Cotswold - Severn long barrows . The connection between the Cotswold- Severn and the French Retz culture is based on the following : -

" There is the exact correspondence of tomb form of barrow proportions, little developed forecourt features and orientation , and even details such as sillstones " , Daniel G.E. (1938) .

Daniel concludes " we may safely envisage the Retz folk from Brittany colonising the eastern shores of the Bristol Channel " . He continues to say that they may have brought more than the (i) transepted gallery graves (e.g. Ty isaf Black Mountains) but also (ii) gallery graves without side chambers (e.g. Ffostill South Black Mountains), perhaps even earlier than the transepted graves , also (iii) the reduction of the gallery grave at the east end of the long barrow to a short rectangular chamber as at Pen y Wyrlod (Black Mountains group) , Manton Down Tinkinswood (Cotswolds).(iv) Finally the reduction of the chamber at a wide eastern end of the long barrow to a formal and non - functional element such as a " false entrance " , " false portal " , " dummy portal " , and placing the chambers in the sides of the long barrow Ty isaf , Pen y Wyrold , Pipton , and Ffostyll , Daniel G.E. (1938) , (see Figures 7.42 , 7.43 , 7.54 and 7.55) .

FIGURE 7.4



DISTRIBUTION MAP OF TRANSEPTED GALLERY GRAVES IN NORTH WESTERN FRANCE .

Black dots : transepted gallery graves .

Precursor of the Cotswold - Severn and Black Mountains long cairns.

Proceedings of the prehistoric society , No 7 , after Daniel G.E. (1939) .

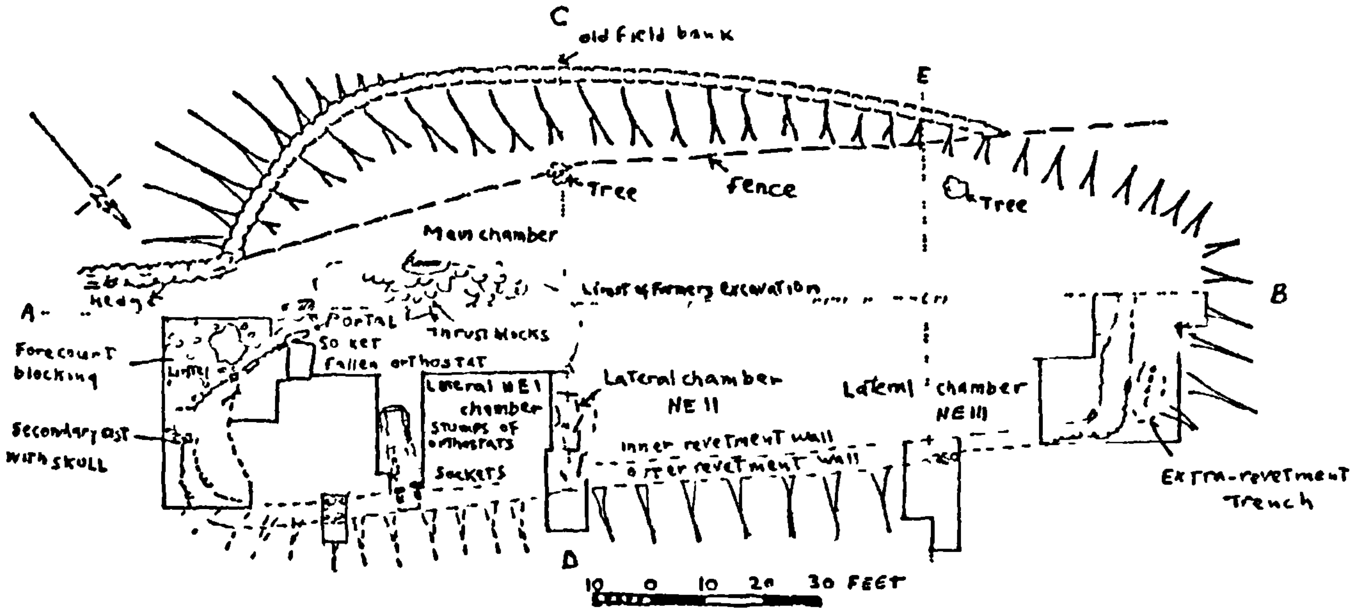


FIG 7 42

PEN-Y-WYRLOD CHAMBERED LONG CAIRN,S OF TALGARTH, BRECKN.
EXCAVATION, SEPT. 1972

AFTER SAVORY 1973

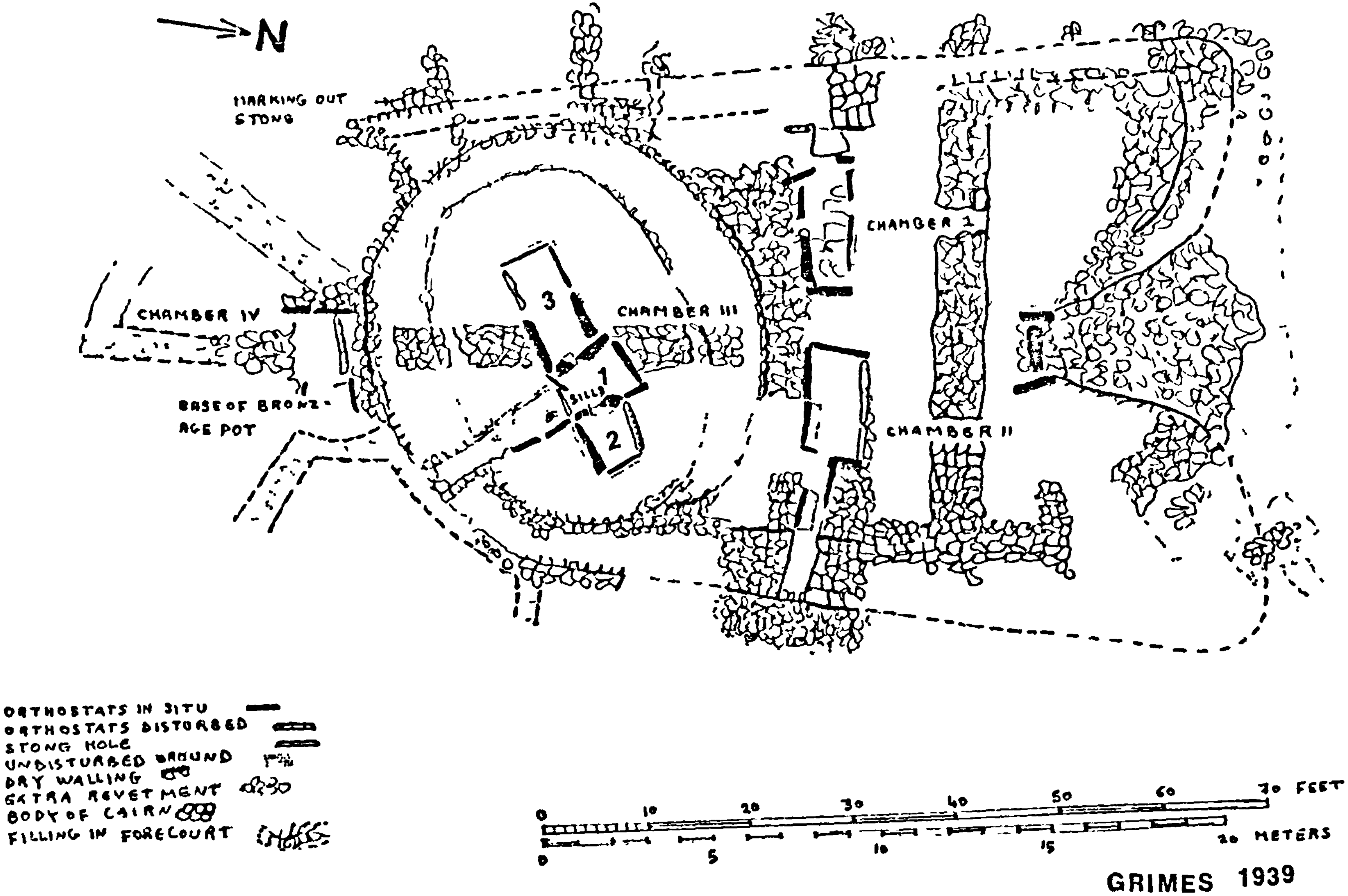
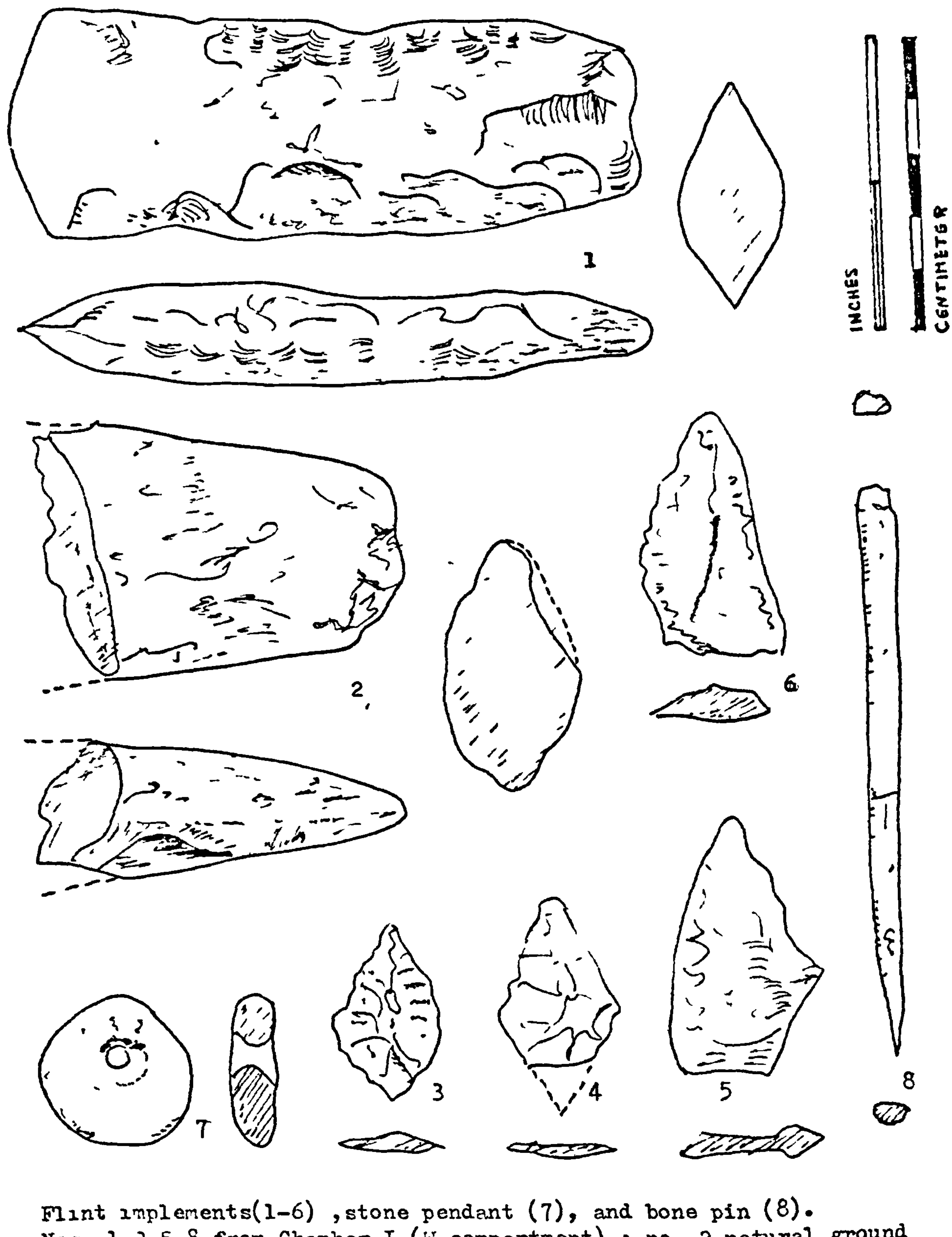


FIG ,7 43 TY ISAF LONG CAIRN BRECKNOCKSHIRE

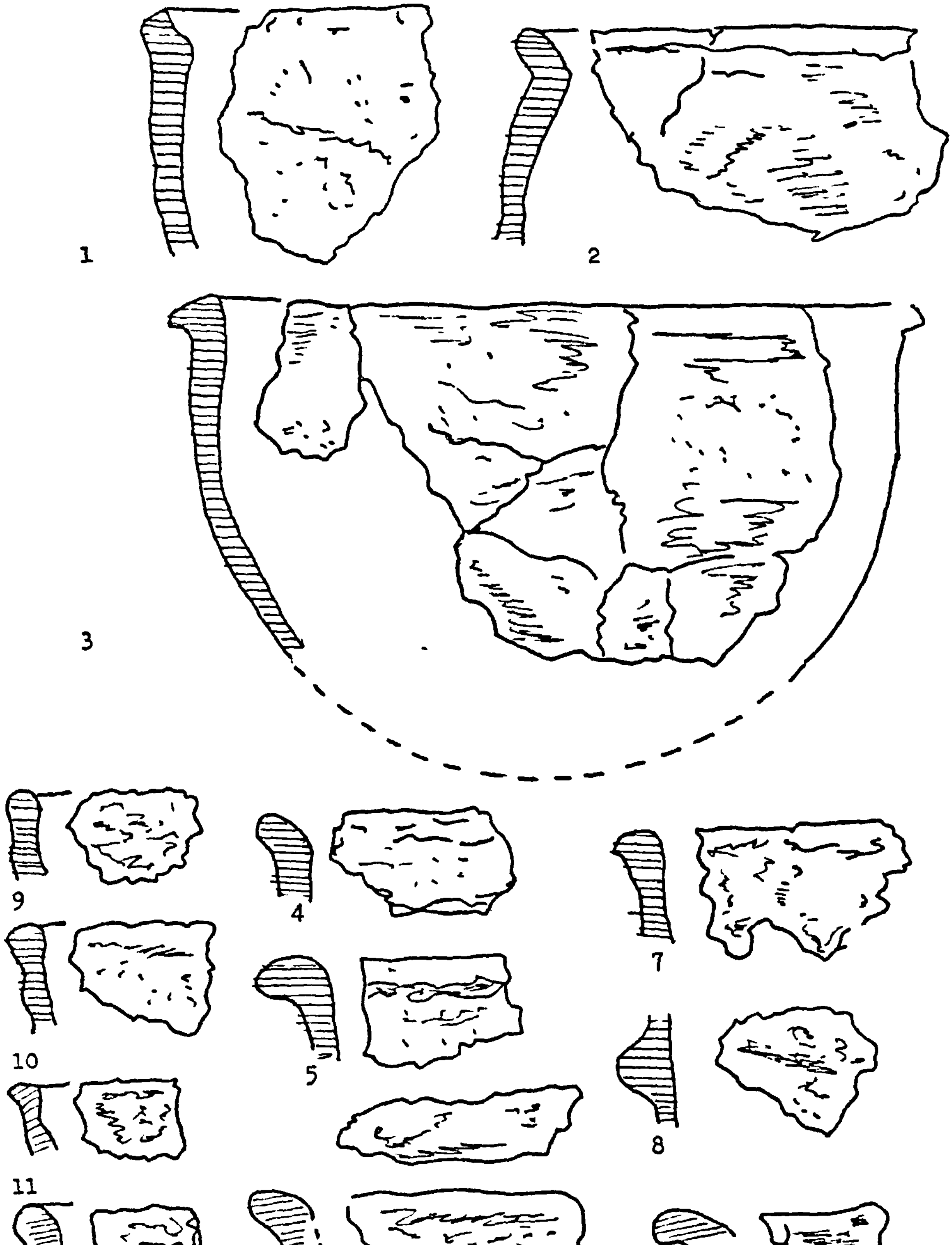
FIGURE 7.44

THE EXCAVATION OF TY.ISAF LONG CAIRN



Flint implements(1-6) ,stone pendant (7), and bone pin (8).
Nos. 1,3-5,8 from Chamber I (W.compartment) ; no. 2 natural ground surface outside 'forecourt'; no 6 Chamber II; no. 7 Chamber II (entrance passage).
The excavation of Ty-isaf Long Cairn , W.F.Grimes, 1939 .

FIGURE 7.45

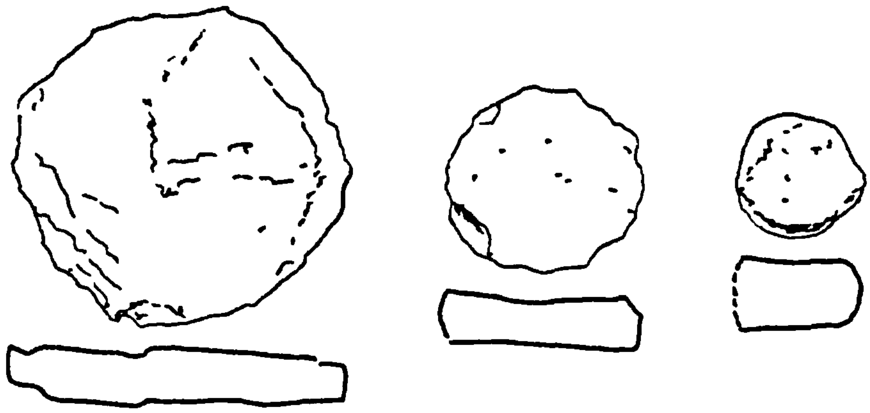


Nos. 1-6 from Chamber II.(2 from entrance passage). Nos. 7-8 Chamber I.
Nos. 9-13 Chamber III (9 from upper layer).

Ty isaf Neolithic 'A' Pottery , ½ Scale.

After Grimes. (1939) .

FIGURE 7.46

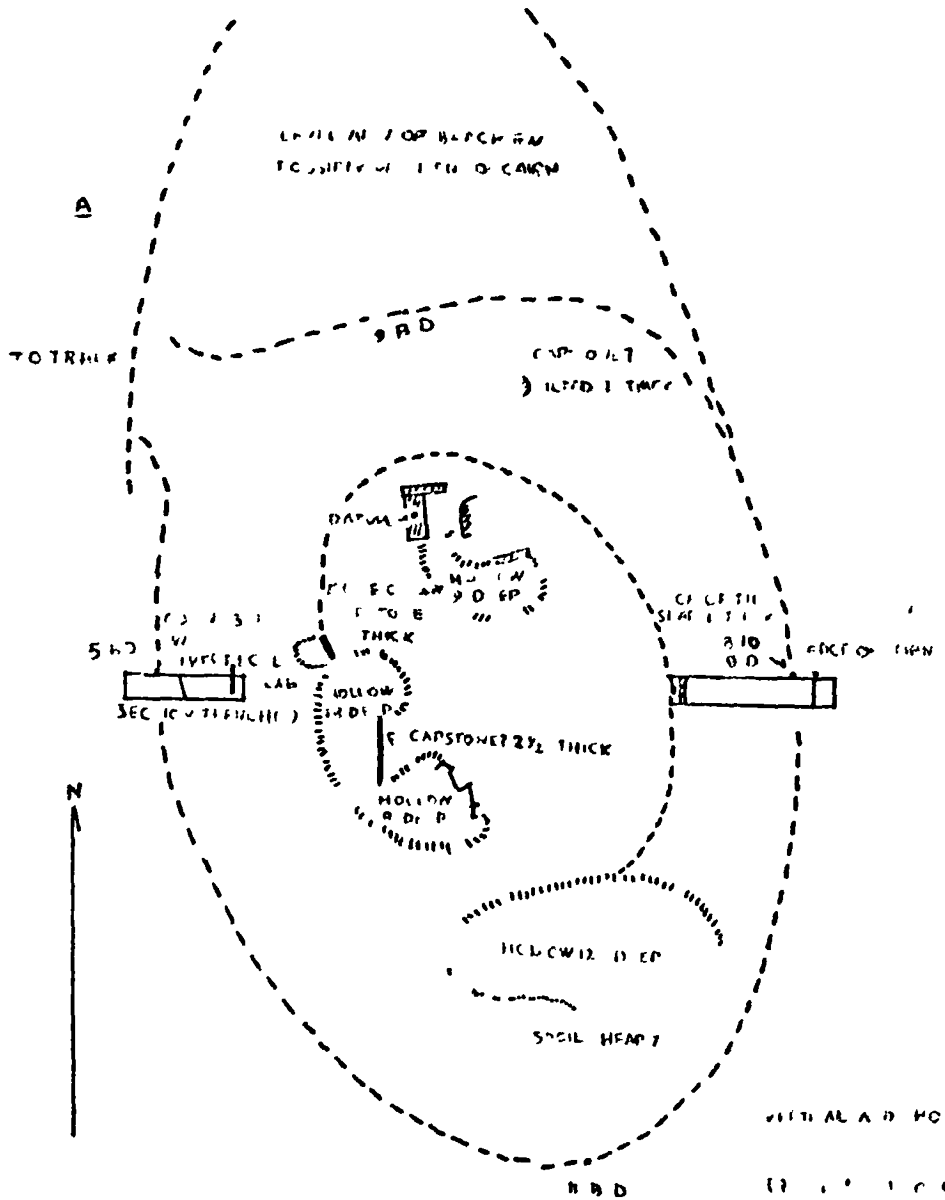


SAND - STONE DISCS

½ Scale .

Graduated weights after Grimes 1939 .

From Ty isaf Long Cairn

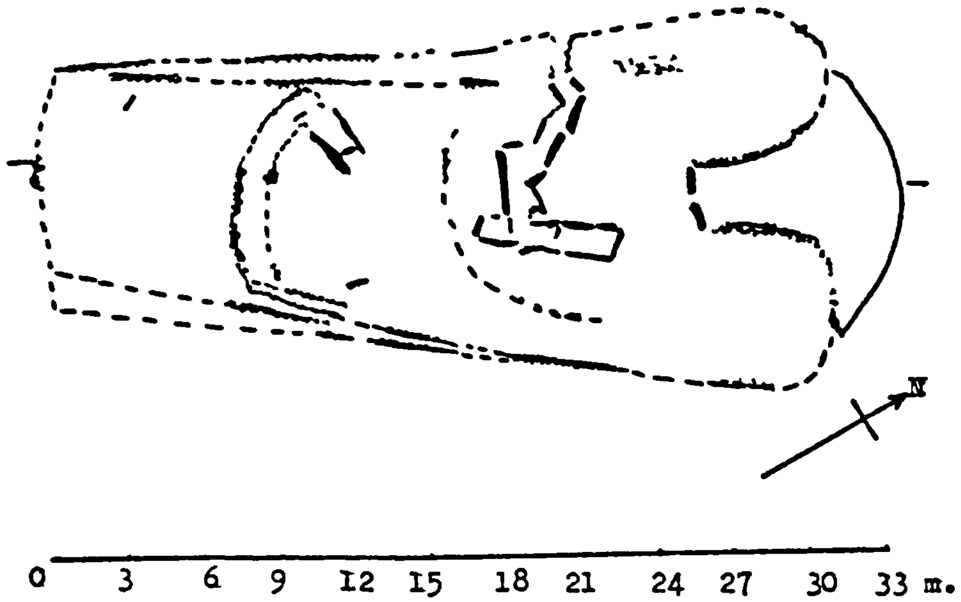


MYNYDD TROED LONG CAIRN

FIG 7 47 WEBLEY 1966

Z

FIGURE 7.48



PIPTON LONG BARROW BRECONSHIRE

After Savory. H.N. 1980

GWERNVALE LONG CAIRN

CRICKHOWELL POWYS

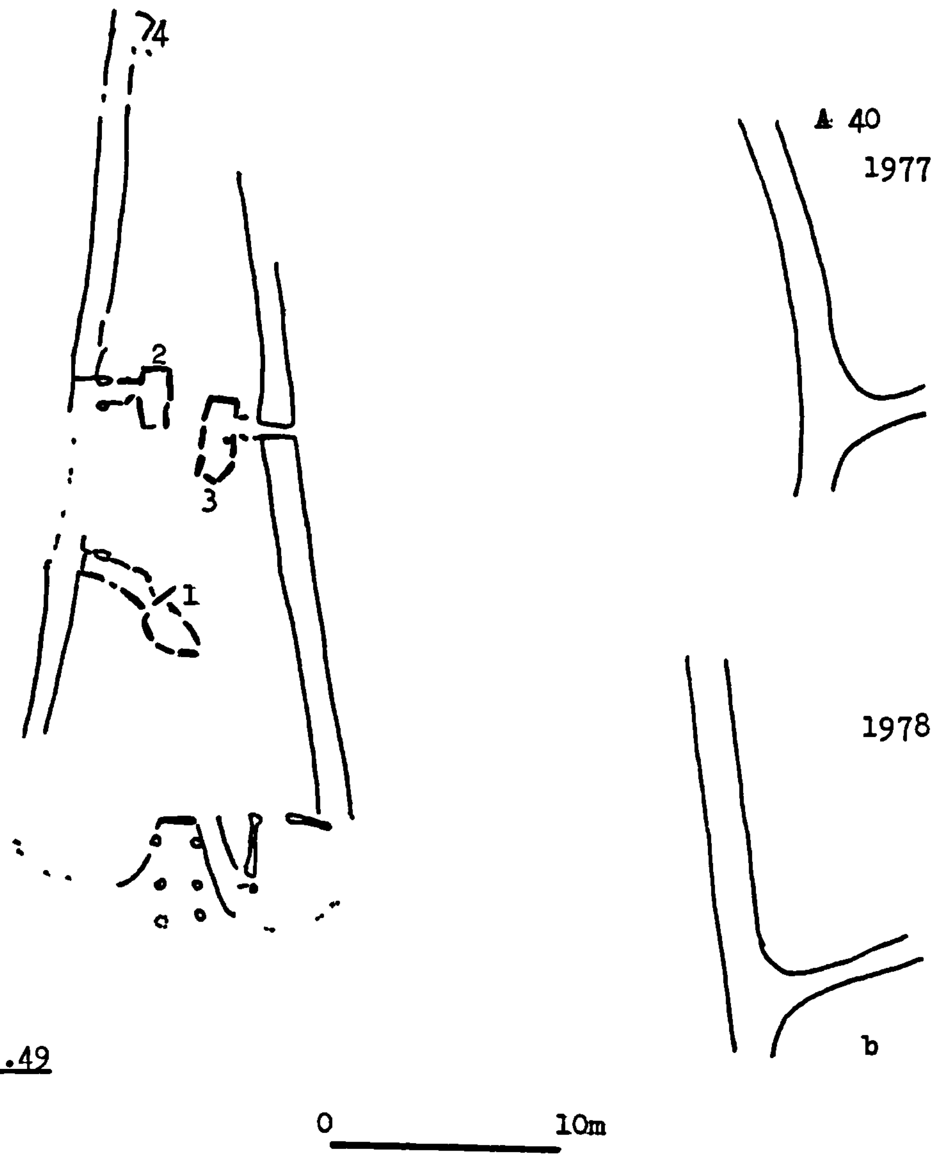


Fig. 7.49

After Britnell (1979) .

FIG. 7.52
NEOLITHIC LONG CAIRNS

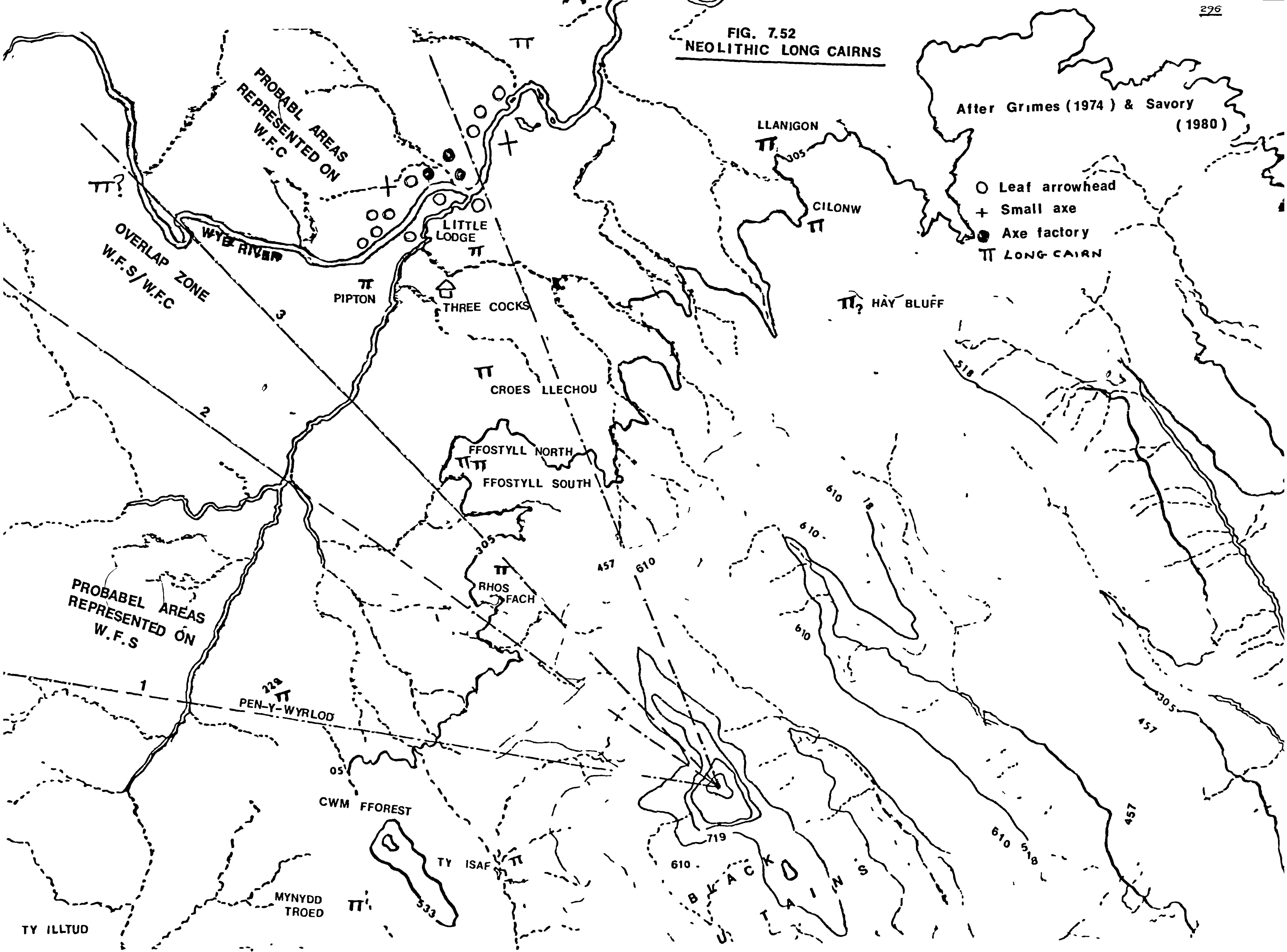
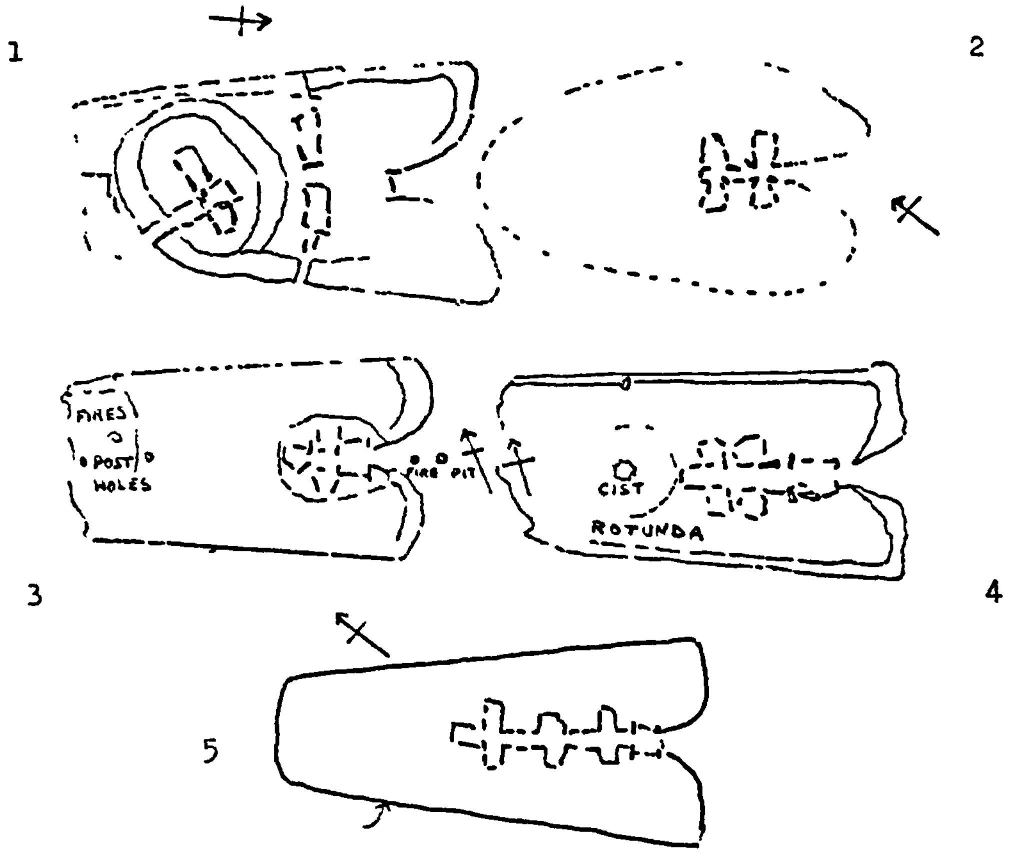


FIGURE 7.54

STRUCTURAL SIMILARITIES IN LONG CAIRNS SHOWING CONNECTION BETWEEN CULTURES



1 : TY ISAF , BRECKNOCKSHIRE . After Grimes .

2 : PARC LE BREOS CWM , GOWER. After Daniel .

3 : NYMPSFIELD , GLOUCESTERSHIRE . After Clifford .

4 : NOTGROVE , GLOUCESTERSHIRE . After Clifford .

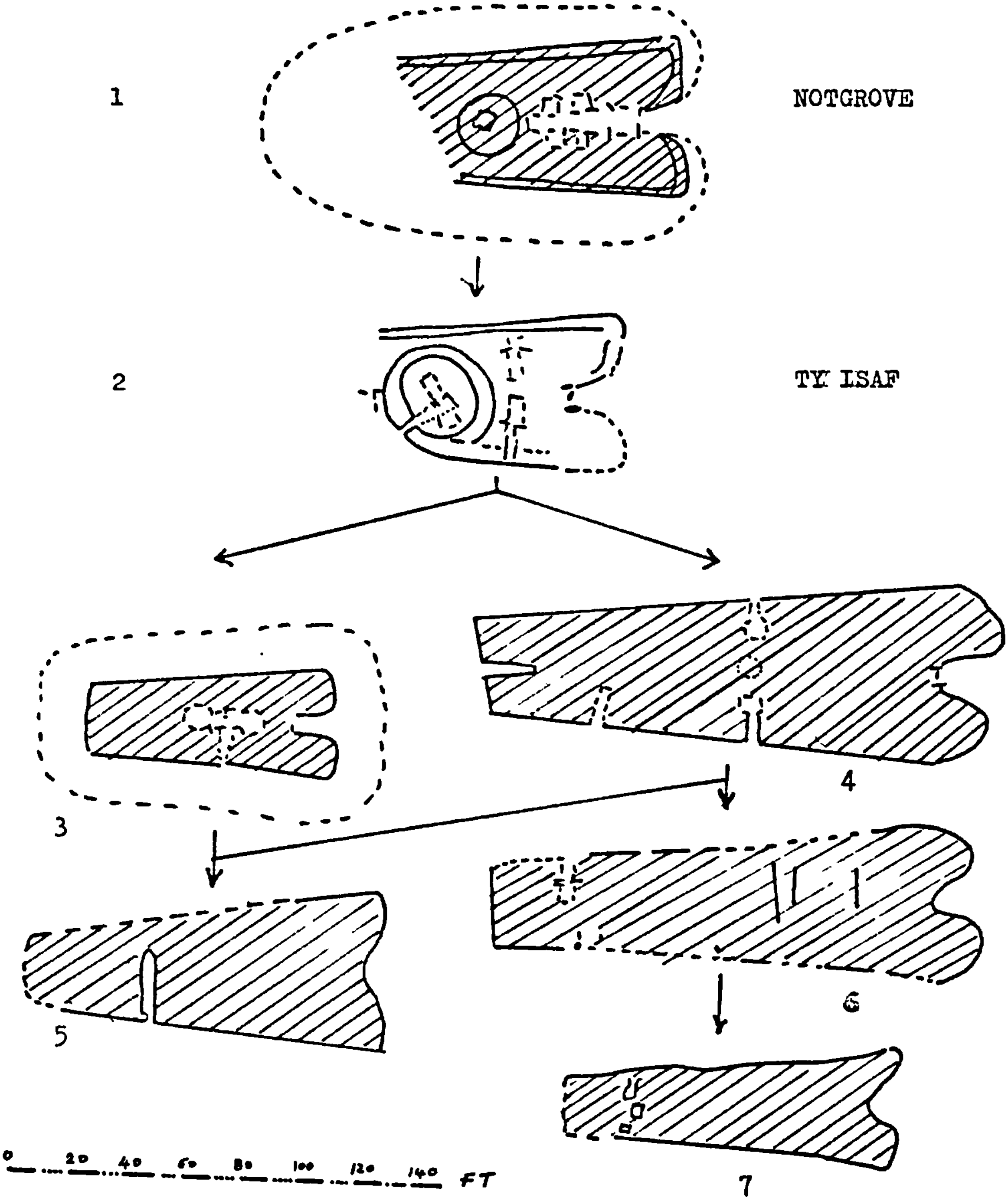
5 : STONEY LITTLETON , SOMERSET .

After Piggott S. (1951) , Neolithic Cultures Of The British Isles .

COTSWOLD - SEVERN CHAMBERED TOMBS

FIGURE 7.55

A COTSWOLD - SEVERN LONG CAIRN SEQUENCE



3 : CAPEL CARMON .
4 : BELAS KNAP .
5 : WEST TUMP .
6 : POLES WOOD SOUTH .
7 : EYFORD .

(After W.F. Grimes , 1939) .

A picture of human activity in the Black Mountains area emerges in the light of palynological evidence which enhances the fragmentary archaeological records .

Recent archaeological evidence suggests human activity in the area as far back as the late upper Palaeolithic period, Green S. (1979 , personal communication) . Very recent unpublished radio-carbon dates of 6900 , 5100 and 4500 years b.p. from the Black Mountains long cairn site at Gwernvale (see Figures 7.49 , 7.52 and Table 7.4) , Britnell , W. (1980 , personal communication) , suggest late Mesolithic to late Neolithic activity , (see Plate 7.0) .

This early human activity continuing over the millenia may have been a contributing factor for a proportion of Betula in the lowlands recorded at the base of the Waun Fach South and Waun Fach Central profiles .

Palynological evidence (with radio-carbon dates from Waun Fach South profile) suggest Neolithic upland clearances on the extensive Waun Fach plateau dating back at least 5000 years b.p. (extrapolated dates) . Before this time a slow growing mor humus layer developed in open woodland community with Polypodium sp. growing as an understorey component and Succisa growing in open areas possibly since Boreal / Atlantic times*.

These very local clearances continued for several centuries after peat initiation proper of the Waun Fach profiles , (this is suggested by a profusion of ruderals at the base of all three Waun Fach profiles, see sections 6.7 , 6.8 and 6.9) .

* See section 6.91 .

The distribution of Neolithic long cairns in the Black Mountains region suggests lowland settlements in two main areas ; first , the Wye lowlands and second the Rhian goll valley . The largest concentration of long cairns is in the Wye lowlands , Savory H.N. (1980), (see Fig. 7.52) . Although the distribution of long cairns gives no direct indication of the Neolithic populations certain information can be gained from archaeological evidence . The size and thus the man - hours required to build a long cairn is an indication of available manpower .

The largest long cairn , Pen-y- Wyrlod (Fig , 7.42) is located in an area of high soil fertility . This site has a greater arable potential than cairns located in narrow valleys e.g. the Ty isaf long barrow(Fig 7.52). It should be noted that the long cairns were not all built at once , but over a period of time e.g. (Ty isaf , Cwm Fforest , Ffostyll North and Ffostyll South) , Savory , H.N (1978) . Also the total number of long cairns may have been substantially greater in the past , Grimes , W.F. (1974) , (personal communication) .

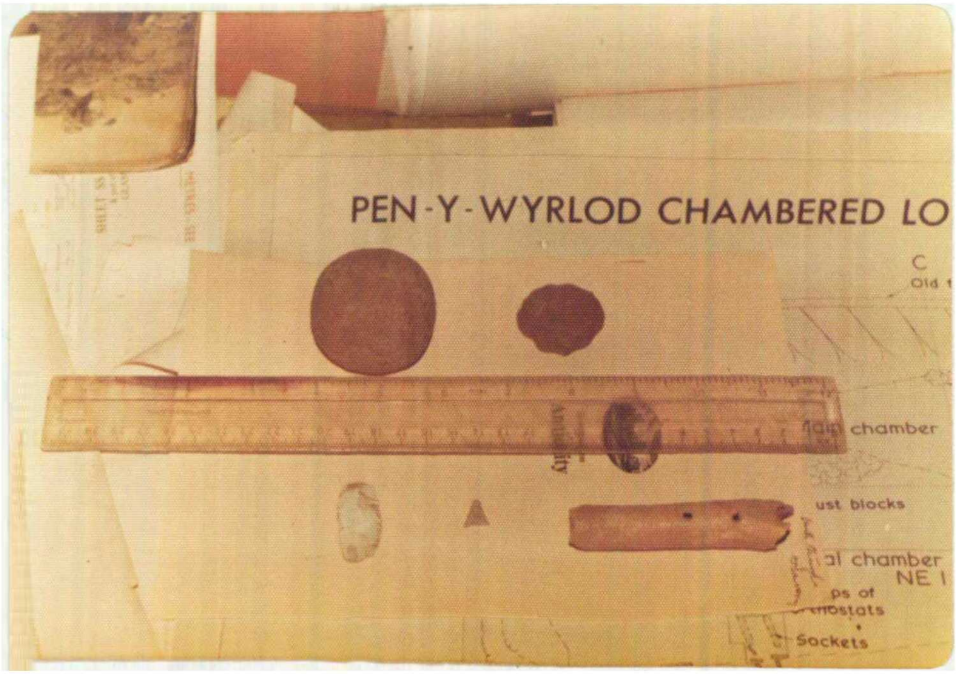
A great deal of information about these early peoples has been obtained by examining the artifacts found in , under , and around the long cairns (Plates 7.0 & 7.43) . Only three long cairns however have been professionally excavated, they are , Pen - y - Wyrlod, Savory H.N. (1972), Ty isaf Grimes W.F. (1939), and Gwernvale , Britnell W. (1979) . Some indication of these peoples way of life are indicated below : -

1 - Evidence of hunting ; The discovery of arrow heads (Ty isaf cairn), and the remains of wild boar and deer (Ty isaf cairn) suggest that hunting had been a common practice,(Fig. 7.44 , Plate 7.43 and Table 7.4) .

2 - Evidence of pastoralism and domestication of animals ;

Ox and sheep / goat bones found inside the Ty isaf cairn are indicative of

Plate 7.43



A small part of the contents from the Pen-y-Wyrlod long cairn (near Talgarth) . Items include Quern stone (arable agriculture) , pottery fragments , flint knife , arrowed head and a whistle .

Pastoralism and domestication of animals (table 7.4) .

3 - Evidence of arable agriculture

The growing of crops was demonstrated by the discovery of Emmer wheat castings (Gwernvale) . Further evidence comes from the several querns at both the Gwernvale and Pen - y - Wyroid long cairns (see Table 7.4) .

4 - Evidence of a seasonal supplementary diet :

Apple and blackberry seeds from the Gwernvale long cairn sites are indicative of fruit consumption . Britnell W. (1979), however , suggests that the fruits may have been imported instead of being locally grown , which suggests the possibility of trade (Table 7.4) .

5 - Evidence for forest clearance :

The discovery of several polished stone axes and knives at several long cairn sites and one on the summit of Pen y Gader-Fawr (800 metres , see section 4.3 ; table 7.4) , does suggest forest clearance (Figure 7.44) .
In addition the construction of settlements (two known , three Cocks and Gwernvale) , (Figure 7.52) , utilizing wood (only postholes remain) gives further evidence for this assumption (table 7.4) . Woodland clearances were also made for long cairn constructions .

6 - Evidence of trade (imported items) :

(a) A reworked Neolithic axe head , from Pen y Gader-Fawr mountain (see section 4.3) .

(b) An imported Wiltshire chert adze from Pen y Gader-Fawr mountain (section 4.3) .

(c) 60 flint and chert fragments scattered over the eastern upper slopes of the Pen Y Gader-Fawr mountain (see section 4.3) .

(d) Neolithic flint and chert fragments from Pen y Wyrlod long cairn , Savory , H.N. (1973) , (plate 7.43) .

(e) Chert fragments from Mynydd Troed long cairn , Crampton , C.B. and Webley , D. , (1966) .

(f) Imported flints from Ffostyll south , Vulliamy , A.C. (1921 - 1923) .

(g) Flint axe from Gwernvale long cairn , Britnell , W . (1979) .

(h) Pottery from the Ty isaf long cairn from (i) Cotswolds , (ii) Mid - Glamorgan , and (iii) Gower , (see table 7.4) .

(i) Gwernvale long cairn pottery from Peterborough (see table 7.4) .

(j) 10 sanstone discs from long cairn at Ty isaf . This may have been used as an earlier form of coinage (see Figure 7.46) .

The preceding " evidence of trade " does suggest distant and varied communication between several communities , several days walk from the Black Mountains .

It has been suggested by many reasearchers , Savory , H.N. (1973) , Webley, D. (1976) , to name just two , that extensive trade links in the form of cattle routes were in existence between the Black Mountains and the Cotswolds . Although this has been documented as far back as the Roman period there is no " hard " evidence to suggest this was the case in prehistoric times .

These clearances resulted in increasing openness of the upland woodlands, and an increase in peat forming communities . Also , from 5000 years b.p. a series of lowland clearance phases were recorded on Waun Fach Central profile (Figure 7.52 , between 5000 to 4500 years b.p.) , and probably encompassing the Ulmus decline , Godwin , H. (1940) , (see sections 6.71 and 6.72), (Plantago lanceolata being the main Plantago sp.) .

This lowland area is represented on Waun Fach Central (see section 6.110 , Fig. 7.52) . This area has a profusion of long cairns and one confirmed settlement site , (see Table 7.4) . Additional lowland clearances were first recorded on the Waun Fach South profile between circa 4500 to 4360 years b.p.. (extrapolated date , 236 to 232 cm horizons) .

The Waun Fach South profile probably represented a more westerly lowland area . This would indicate that clearance activity had shifted to a more westerly location , (see Figure 7.52) . The largest Cotswold seven long cairn , Pen y Wyrlod is in this lowland area and this may have been the centre of activity .

The presence of Plantago major-media during the Waun Fach South clearance phase does suggest a separate clearance episode from that on Waun Fach Central and not just a synchronous event . Also the presence of Plantago major-media could suggest clearances for arable agriculture. This suggests a change from pastoral clearances on Waun Fach Central to arable on Waun Fach South .

Indeed, querns were found at the Pen y Wyrlod long cairn site by Savory H.N. (1974) , (see Table 7.4) . The change in land use may reflect the infusion of new groups of people into the Neolithic population . However , clearances on Waun Fach South appear less intense and extensive than on Waun Fach Central . This may reflect a reduction in population due to natural disaster ; e.g. epidemic or a partial migration out of the area of the original inhabitants.

During this period from about 5000 to 4350 years b.p. several short disturbances were recorded on the Waun Fach North profile , both during and after the Ulmus decline (see section 6.9 and 6.100) . These clearances represent disturbances in the uplands of Grwyne Fawr valley which is represented on Waun Fach North (see section 6.110) .

A lull in clearance activity between 4350 to 3650 years b.p. (extrapolated dates) was recorded on both the Waun Fach South and Waun Fach Central profiles (see Table 7.5a). This could suggest a decline in the lowland population . During this lull in lowland activity upland clearances , with Plantago lanceolata pollen present, were recorded on the Waun Fach North profile circa 4100 to 3600 years b.p. (204 to 192 cm horizon) and on the Pen y Gader-Fawr profile 3800 years b.p. , 116 cm and at 3700 years b.p. , 111 cms. horizon (all extrapolated dates) .

If the estimated date of these clearance horizons on Waun Fach North is accurate , then this represents a continuum between the late Neolithic and the Bronze age .

The location of these clearances recorded on Waun Fach North are most probably those which occured on the Pen y Gader-Fawr

TABLE 7.5a

W.F.N.	W.F.C.	W.F.S.
	203 cm 3400 Y.b.p.	
192 cm 3550 Y.b.p.		
		215 cm 3650 Y.b.p.
	Bronze age	
204 cm 4100 Y.b.p.		
		232 cm. 4350 Y.b.p.
	233 cm 4500 Y.b.p.	236 cm 4500 Y.b.p.
Neolithic		

Table 7.5a Clearance phase on the Waun Fach North , Central and South profiles , showing breaks or lulls in clearance activity , possibly between the Neolithic and Breaks age periods.

Y.b.p. = Years b.p.

mountain , except on its eastern flank . That means that this profile could have recorded both the clearances that contributed to peat initiation on Pen y Gader-Fawr and subsequent early Bronze age clearances which followed peat initiation .

It is assumed that pollen-laden winds were blowing up the Grwyne Fawr valley and on to the Waun Fach North profile . This has been substantiated by surface pollen studies recording unusually high T.A.P. of Picea and Pinus on Waun Fach North . The main area from which these heavy pollen grains most probably came is the eastern flank of the Pen y Gader-Fawr mountains (see sections 3.24 & 6.110 , and Figure 6.110) .

This change from Waun Fach South , Waun Fach Central to Waun Fach North and Pen y Gader-Fawr profiles , may suggest a change in land use from essentially lowland to upland areas . This could reflect a new influx of peoples into the area by the late Neolithic or early Bronze age peoples .

The utilization of primarily upland areas may reflect a climatic change more towards a milder climate , allowing increased periods for upland grazing . The profusion of Bronze age barrows on the western uplands in the Llanbedr valley and a Bronze axe on the Pen y Gader-Fawr summit suggests that, this interpretation of pollen data and upland land use is plausible .

Clearance activities were resumed on Waun Fach South at 3650 extrapolated years b.p. (215 cm) , and spanned a period of about 200 years . This involved the clearance of Ulmus and Quercus . Ulmus was apparently heavily cleared as indicated by a sharp drop in its T.A.P. The severity of clearances is also demonstrated by the appearance of Fraxinus with a substantial showing.

Clearances also started at about 3600 years b.p. on Waun Fach Central but an increase in Fraxinus is not recorded on Waun Fach Central nor on Waun Fach North profile . This indicates that clearances on Waun Fach South were in well-drained fertile areas , possibly only 4 kilometres away in the Waun Fach South area of the Wye lowlands illustrated by the round barrow map (Figure 7.3) . The presence of Plantago lanceolata and other indicative ruderals suggest that clearances were mainly pastoral .

The Waun Fach Central profile , on the other hand , shows a different picture of clearances during the time period encompassing the Bronze age . For , on the Waun Fach Central profile , clearance activities appear to be more severe and more frequent than those on Waun Fach South . This may be indicative of a larger population in the areas represented on Waun Fach Central . Also the large number of arable clearances represented on Waun Fach Central is unique on the Black Mountains profiles .

The synchronous removal of Pinus on both profiles is indicative of clearances on well-drained soils probably on the hillsides in the north-west of the Black Mountains (see Figure 6.110) .

The increased utilization of hillside grazing areas, i.e. on the rolling hillsides leading down to the Wye river lowlands is consistant with the round barrow map (see Figure 7.3) , showing the distribution of round barrows several of which are on the gently rolling hill at the base of the Black Mountains .

After the lull in clearance activity on Pen y Gader - Fawr , after 3700 years b.p. , there followed a much more intensive clearance phase at 3200 extrapolated years b.p. (96 cm horizon), when Ulmus was cleared to apparent extinction . At the same time , there were only slight clearances of Quercus .

This marked selection of Ulmus , which represented a drop from 5 % T.A.P. , suggests a special reason for cutting Ulmus such as the use of leaves and branches for winter fodder etc, Pennington W . , (1969) . This second clearance episode may well have been due to a new population influx by the middle Bronze age peoples .

SUMMARY

Neolithic activity in the Black Mountains area was pre - dominently pastoral and concentrated in specific lowland areas . Shifting pastoralism and Landnam clearances are also indicated . The Ulmus decline varies in nature with location and may well be anthropogenic . It does not appear as one single clearance phase , but rather a series of clearance phases with Ulmus regeneration in-between clearances .

Stone axes and knives were used for both lowland and upland clearances . Domesticated animals such as , ox , sheep/goats were also kept and could graze on the cleared patches of land . Some limited arable agriculture (wheat) took place probably after an initial period of exclusive pastoralism .

Hunting was also practiced as arrowheads , polecat and wild boar remains , clearly demonstrate (see Table 7.4) , trade in varying forms was present either in the form of new immigration into the area or , battles or straight barter , (see Table 7.4) .

Lowland clearances during the Neolithic were small scale and could be envisaged as small patches of cleared ground , which were then left for other freshly cleared areas . The considerable man hours spent in cairn construction suggest centres of worship . These centres of worship were probably maintained as clear patches in the woodlands .

Ulmus ard to a lesser extent Tilia appear to have been important trees to Neolithic man, with their leaves and bark , probably , used as winter fodder .

From the beginning of peat initiation circa 5100 years b.p. upland clearances were on Waun Fach South . Woodlands on upland ridges and plateau appear to be less dense and were well suited for summer grazing . Betula was probably a more significant plant component than in lowland areas .

The cumulative effects of upland woodland clearances due to felling and / or grazing favoured a progressive denudation of the arboreal canopy . These processes also made conditions more conducive for true peat formation and subsequent expansion of peat forming communities . However , upland clearances during this period were of secondary importance to lowland activities .

Clearance activity shifted to predominently upland areas in the Beaker or early Bronze age and may have contributed to peat initiation on the Pen y Gader - Fawr mountain . This mountain and the west Llanbedr valley ridge being particularly rich in finds and likely areas for upland pastoral clearances .

Betula became an even more prominent member of the upland flora together with Quercus and perhaps Ulmus and Tilia in the early stages. During the middle to late Bronze age 3600 to 3300 onwards, clearance activity resumed in lowland areas , as well as , upland areas, and were predominently pastoral . Larger populations may be indicated by the greater magnitude of clearances on Waun Fach South , Waun Fach Central and Pen y Gader - Fawr profiles .

Arable clearances increased during this period . Upland areas were particularly vulnerable to clearances with the cumulative effects on larger areas displaying no arboreal regeneration and grasslands as well as heathlands expanding . It will be seen in the late Bronze age , circa 2800 years b.p. , that clearances became more widespread and intense , with few arable clearances (see section 7.3) .

PFRIOD C

CORRELATION OF WAUN F^ ^H SOUTH ,WAUN FACH CENTRAL ,WAUN FACH NORTH AND PEN y GADER-FAWR BETWEEN 3000 TO 2350 EXTRAPOLATED YEARS b.p.

These profiles are represented in the following horizons ;

Waun Fach South	201 to 159 cm
Waun Fach Central	194 to 150 cm
Waun Fach North	180 to 155 cm
Pen y Gader-Fawr	92 to circa 68 cm

7.3 This period between 3000 to 2350 extrapolated years b.p. encompasses the latter part of the Bronze age and continues up to the early - middle Iron age period .

The Pen y Gader-Fawr profile shows greatest clearance activity amongst all the profiles . These clearances which started in 3360 extrapolated years b.p. (Period D) steadily increase to a peak in activity between 3000 to 2800 extrapolated years b.p. Neither Ulmus nor Tilia were recorded at this peak of activity . Tilia in particular never fully regenerates throughout the remainder of the profile . These clearances probably occured along the western and eastern mountain ridges of the Llanbedr valley (see Fig. 6.110) .

Archaeological evidence for this clearance activitv are a long line of round barrows situated along the western ridge of this valley (see Fig 7.3). Rich soils must have covered these now barren ridges which originally supported both Ulmus and Tilia . It is probable that after the height of clearances these ridges were devoid of trees, i.e. 2800 years b.p. at 83 cm (Fig. 6.61).

The Waun Fach profiles show a very different palynological record from Pen y Gader-Fawr . The least clearance activity is recorded on Waun Fach North , on this profile Ulmus which up to this period represented approximately

25 % T.A.P. , declines sharply and was accompanied by a delayed showing of <u>Plantago lanceolata</u> (see Fig. 6.91) . The date of this decrease in <u>Ulmus</u> pollen was about 2800 to 2700 extrapolated years b.p. at 175 to 165 cm horizons , which was probably the late Bronze age . The probable location of these clearances was on the upper eastern slopes of the Pen y Gader-Fawr mountains or at the mouth of the Grwyne Fawr valley . In both these areas there have been Bronze age finds (see section 4.3 , Figures 7.3 and 7.31).

It is however possible that these clearances may have been a proportion of the same widespread clearances recorded on Pen y Gader-Fawr mentioned in the preceeding paragraph .

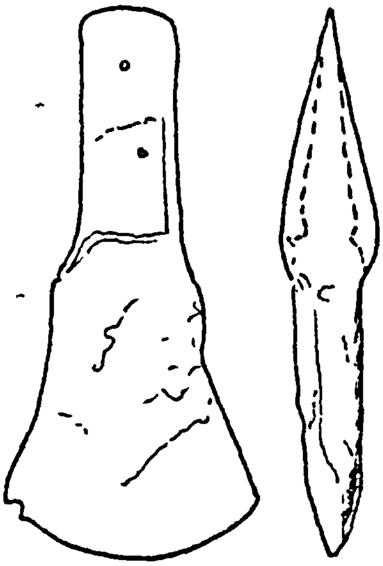
On this Waun Fach North profile <u>Ulmus</u> continues to decline between the 155 to 150 cm horizon (2670 to 2600 extrapolated years b.p.) , in spite of the absence of human activity . This assumption is supported by the low T.A.P. percentages of <u>Betula</u> and <u>Fraxinus</u> often after human disturbances , Moore, P.D. and Chater , E.H. (1969).

A possible explanation of this decline was the extensive and prolonged upland clearances on the eastern upper slopes of Pen y Gader-Fawr . This could have caused increased run off and subsequent leaching of soil nutrients in the woodlands beneath the mountain ridge where activity was centred Thus slope soils were unsuitable for <u>Ulmus</u> growth . Also this increased moisture content of the soil , suitable for <u>Alnus</u> , of which there were substantial increases , (see Figures 7.31) .

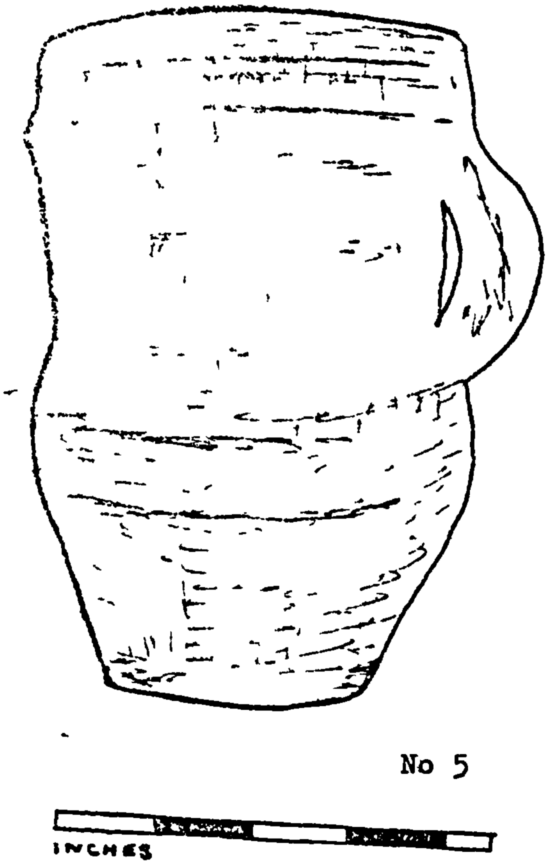
Both the Waun Fach Central and Waun Fach South profiles reveal increased clearance activity particularly between 2800 to 2700 extrapolated years b.p. The activity on Waun Fach Central was slightly greater . Clearances of Waun Fach South and Waun Fach Central were also less intense than those on Pen y Gader-Fawr . This as one might expect from the high density of round

FIGURE 7.31

OBJECTS OF BRONZE AGE DATE FROM THE BLACK MOUNTAINS AREA



No 1 , ½ Scale



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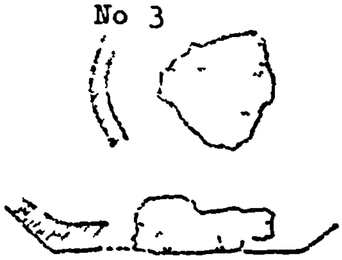

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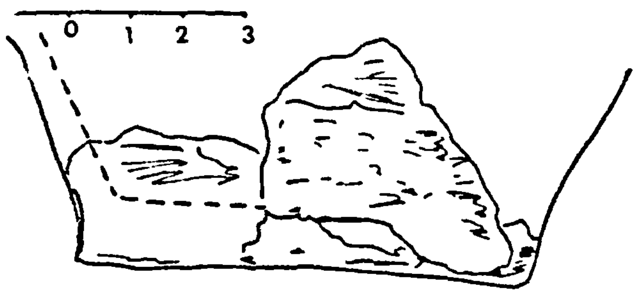


No 1 . Bronze Axe, from pen y Gader-Fawer Mountain .
No 2 : Broken Bone Knife or Dager Handle, Chamber IV, Ty isaf Long Cairn.
No 3 : Fragments of 'A' Beaker Pottery, Ty isaf Long Cairn, after Grimes .
No 4 : Fragments of Cinerary Urn Chamber IV, Ty isaf Long Cairn.
No 5 : Bronze Age handled Beaker, from GWM du Black Mountains, Grimes 1925.

barrows close to the Pen y Gader-Fawr profile site compared with low densities around Waun Fach South and Waun Fach Central profile sites (see Fig. 7.3).

It is interesting to note that the upland round barrows sites represented on the Pen y Gader-Fawr profile are located at considerably higher altitude than those sites represented on the Waun Fach South and Waun Fach Central profiles (see section 6.110 , Plate 7.41).

This suggests that more time was spent in upland areas . The building up of summer dwellings on the upland ridges is also a possibility to manage sheep on the extensive upland grazing areas.

It will be seen from figure 7.3 that these are two loose clusters of round barrows on the Wye valley . One in the Waun Fach South zone of the Wye lowland recorded on Waun Fach South and another in the Waun Fach Central. zone . The Waun Fach Central cluster of round barrows contains more barrows .

This would indicate that the population here was larger and that clearances were greater than in the Waun Fach South area of these lowlands . This is confirmed by the fact that on the Waun Fach Central profile there is a greater incidence of <u>Fraxinus</u> , <u>Plantago lanceolata</u> and other weeds . These taken together indicate greater human activity, Moore P.D. & Chater E.H. (1969).

Clearances for arable agriculture during Period C , are rare . On the Wye lowlands only one clearance at 2750 extrapolated years b.p.(189 cms. W.F.C) had significant arable herb indicators*. The sparsity of arable agriculture indicates low cereal production by these mainly pastoral people. This is in marked contrast to the situation earlier between 3400 and 3150 extrapolated years b.p. (Period D , 208 to 198 cms horizon) .

At this time , possibly , middle Bronze age , an expansion of agriculture was brought about by man , in the Wye lowlands . This could be an indication that there may have been a different agricultural emphasis during the middle Bronze age and the late Bronze age times . Also it is possible that this

*For a list of arable indicators see appendix , Table 6.2 .

Plate 7.41

Another Bronze age barrow remains on mountain ridge separating the Rhian goll and the Llanbedr valleys .

Verified by Savory H.N. (1979) .

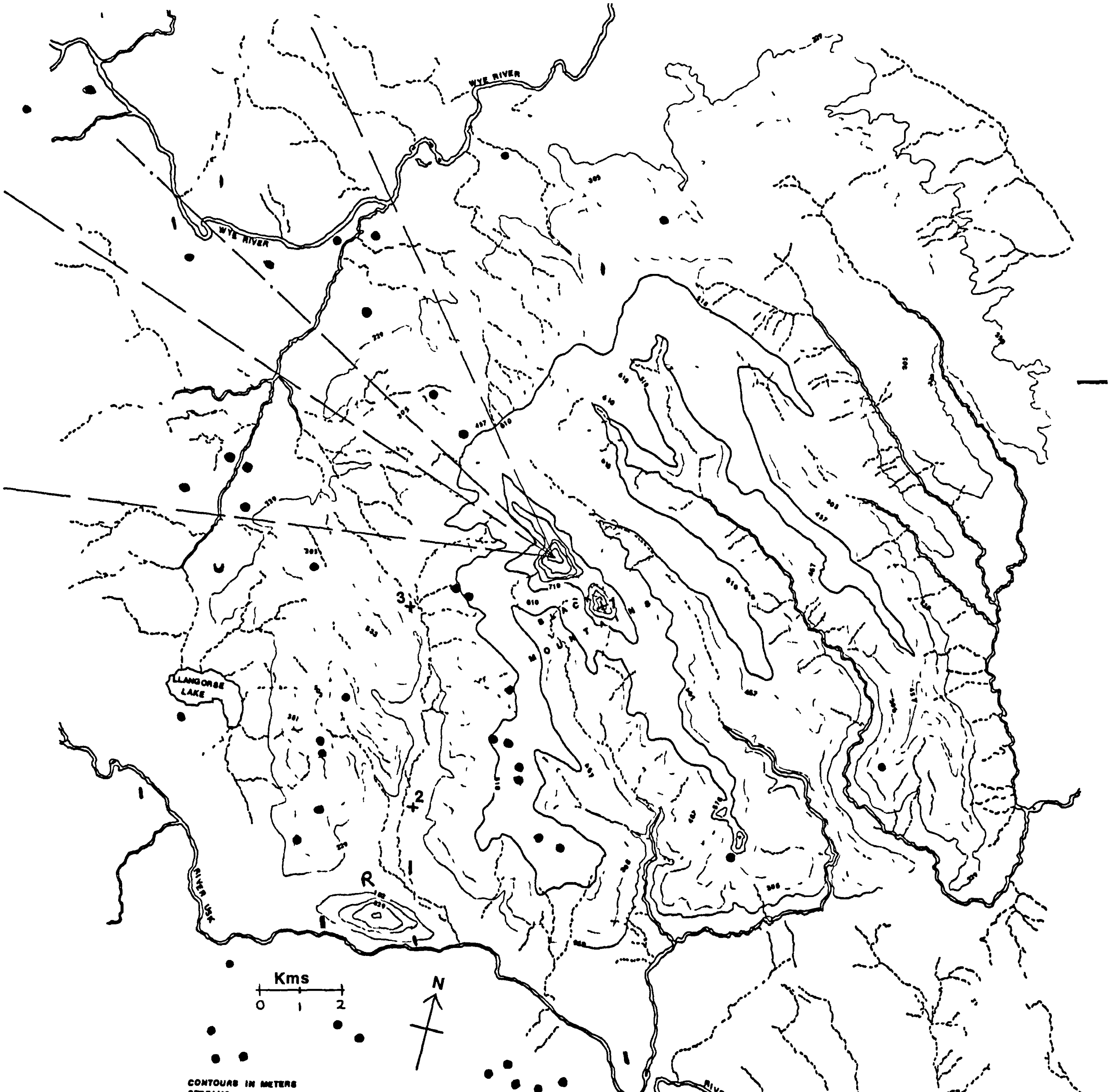


FIG. 7.3

Bronze Age Barrows ●
in the Black Mountains Area
Breconshire.

Bronze Age finds listed in thesis: +

No.1. Bronze Age Axe from Pen Y Gader-Fawer Mountain.

No.2. 'A' Beaker handled Beaker from CWM du. (Late Neolithic)

No.3. Bronze Age Cinerary URN fragments from Ty Isaf Long Cairn.

Bronze Age Standing Stones: I.

Bronze Age Beaker site: ◡.

Roman Fort: R.

change in emphasis from arable to pastoral agriculture was due to a change in climate . Alternatively there may have been an influx of new peoples into the Black Mountains area .

THE PALYNOLOGICAL EVIDENCE FOR THIS PERIOD UP TO 2700 EXTRAPOLATED YEARS b.p MAY BE SUMMARIZED AS FOLLOWS .

7.31 Substantial increases in clearance activity were recorded on the Pen y Gader-Fawr , Waun Fach Central and Waun Fach South profiles . This suggests a growth in population in the Black Mountains area when compared to earlier Bronze age and Neolithic periods . The substantial human activity on the western uplands of the Black Mountains is consistant with the concentration of round barrows on this same mountain divide between the Rhian goll valley and Llanbedr valley . This would suggest that most of the barrows on this mountain ridge were built in the late Bronze age period .

Pastoral agriculture appears to have been the main-stay of these late Bronze age peoples . There was probably an extensive use of Ulmus leaves and bark used for winter fodder, Pennington W. (1969), Heybroek H.M. (1963).

This is indicated by substantial Ulmus felling in upland areas (recorded on Waun Fach North and Pen y Gader-Fawr) . This practice was probably also used in Neolithic times in the Black Mountains area (Period D) , and is still being used in parts of South Wales today , Smith A.G. (1979) , and is observed to be used by one farmer in the Grwyne Fawr valley (personal observation) .

CORRELATION OF THE BLACK MOUNTAINS PROFILES BETWEEN 2700 TO 2400 EXTRAPOLATED YEARS b.p.

7.32 After approximately 2700 extrapolated years b.p. a reduction of clearance activity was recorded in these profiles . During this period extensive woodland regenerations took place in the Wye lowland areas recorded on Waun Fach South and Waun Fach Central . In some parts of these woodlands there was Ulmus regeneration .

Most Black Mountains upland areas above 640 metres were already devoid of trees as a result of : -

1 - Repeated tree felling .

2 - Grazing pressures .

3 - Leaching of nutrients from the soil .

4 - Subsequent peat initiation .

Woodlands on the remaining upland were sparse and open . For example open woodlands may have persisted up to peat initiation at 2345 years b.p.* The Grwyne Fawr valley however still retained a thick cover of Quercus / Alnus woodlands with the lowest proportions of Betula in any of the Black Mountains profiles .

Ulmus actually made a substantial regeneration (2700 to 2600 extra - polated years b.p. , 160 to 155 cm horizon) . Ulmus also regenerated slightly on the Pen y Gader-Fawr profile , but to a lesser degree . This was because of continued low clearance activity probably in the Llanbedr valley .

The general decrease in clearance activity recorded on all four profiles represented the period between the late Bronze age and the early - middle Iron age . This transitional period of low clearance indicates a substantially reduced population in the Black Mountains region . This is particularly

* Date of peat initiation of the Ty isaf profile .

interesting because there is no indication in the archaeological evidence of relative population reductions at this time . It is possible that wars , migrations , or natural disasters may have been responsible for the fall in population .

From about 2400 extrapolated years b.p. new increases in clearance activity were recorded on four profiles, Waun Fach North , Waun Fach South , Waun Fach Central and Pen y Gader-Fawr . This period may well represent the start of the Iron age in the Black Mountains . If this is correct these Iron age peoples brought with them not only a new culture but a new technology that was useful both in warfare and land use . This technology involved the use of Iron , Bowen , E.G. (1970) , and Davies , D.J. (1933) . (see Plate 7.1 & 7.2) .

Plate 7.1

Plate 7.2

Plate 7.1 : Mynydd Troed Mountain (SO . 165 292), and the northern portion of the Rhian goll valley in the distance, to the far right is the Wye river lowlands .

Plate 7.2 : The same location except taken at dusk giving the mountain a dark black appearance . This valley has a remarkable collection of archaeological structures reaching 5000 years b.p.

Plate 7.40

Remains of a Bronze Age barrow in the Rhian goll valley and below the Ty isaf sample site (SO . 203287) .
Verified by Savory H.N. (1979) .

PERIOD B

CORRELATION OF ALL FIVE BLACK MOUNTAINS PROFILES BETWEEN 2350 TO 1500 EXTRAPOLATED YEARS b.p.

7.2 These profiles are represented in the following horizons :

Site	Peath depth in cm	Radio-carbon years b.p. extrapolated
Waun Fach South	159 to 90 cm	2350 to 1500
Waun Fach Centre	150 to 75 cm ,	" "
Waun Fach North	135 to 75 cm	" "
Pen y Gader-Fawr	68 to 42 cm ,	" "
Ty isaf	72 to 49 cm	2200 to 1500

This period extends from approximately 2350 to 1500. years b.p. and includes portions of the Iron Age , the whole of the Roman conquest and subsequent occupation and the return to a less stable period of warring tribes.

The period includes the most extensive and longest duration of clearances of all profiles with the possible exception of period A on Waun Fach North and Ty isaf .

The shape of the Plantago T.A.P. curves often show similarities between profiles but the starting dates of clearances are often very different . Another feature of this period is the appearance on a wide scale of arable agriculture indicated by the presence of Plantago major-media , Chenopodiaceae , Taraxacum type and the first appearance of cereals . The timing of this shift in agricultural emphasis is significant because it suggests permanent settlements , possibly influenced by the Romans, and the need to feed a greatly enlarged population .

On the Ty isaf profile the beginning of the period is particularly significant because it follows peat initiation underlain by charcoal with a radio-carbon date of 2345 ± 70 years b.p. (uncorrected date) .
This strongly suggests an anthropogenic cause of peat initiation and indicates that clearances occured up to at least 600 metre contour, i.e. Ty isaf site .

Of the 45 Iron age hill forts occupied by the Silures on the Wye in Breconshire , three are located in the Rhian goll valley . These are Castel Dinas , Pentir and Coed Gaer (table 7.24) .
Castel Dinas in particular is situated just below the sample site on Ty isaf and is of a similar design and age to Tw n y Gaer in Monmouthshire which is dated 2430 to 2330 years b.p. Savory , H.N. , (1950) .

It is highly probable therefore that these forest clearances were associated with the local hill forts communities and that as a result of the clearances by fire , peat initiation could commence , Chisholm, M. (1962), states that

TABLE 7.24

IRON AGE HILL FORTS IN THE BLACK MOUNTAINS REGION

Name of the hill fort	Geographic area	B.M. profile recorded	Arable potential %	Terrain	Other facts
1. Twyn-Y-Gaer	Wye lowlands	W.F.S.	____	Flat	
2. Pen Rhiwwen	"	W.F.C.	85	"	
3. Twyn Y Garth	"	W.F.C ?	____	"	
4. Pwll Y Cwru	"	WFS/WFC	____	"	
5. Hillis	"	WFS/WFC	85	"	
6. Llwyfen	"	WFS/WFC	95	"	
7. Drostre	"	W.F.S.	85	"	
8. Court Y Gaer	"	W.F.S.	80+	"	
9. Pendre	"	WFS/WFC	85	"	
10. Aberlynfi (1)	"	W.F.C.	85+	"	
11. Aberlynfi (2)	"	W.F.C.	85+	"	
12. Castel Dinas	Rhian goll	Ty isaf	70	Hilly	2430-2330 built B.P.
13. Pentir	"	Ty isaf	80	"	
14. Coed Gaer	"	Ty isf	____	"	
15. Crug Hyell	Mouth of Llanbedr	P.Y.G.F.	60	"	2430-2330 built B.P.
16. Pen Frisk	Usk lowlands	P.Y.G.F.?	85	Flat	
17. Gaer Llanelly	"	P.Y.G.F.?	____	"	
18. Twyn-Y-Gaer	Grwyne-Fawr valley	W.F.N.	70	Hilly	

NOTE Percentage of arable potential refers to percentage of arable land inside the hill fort enclosure, After Savory H.N. (1950-1951).

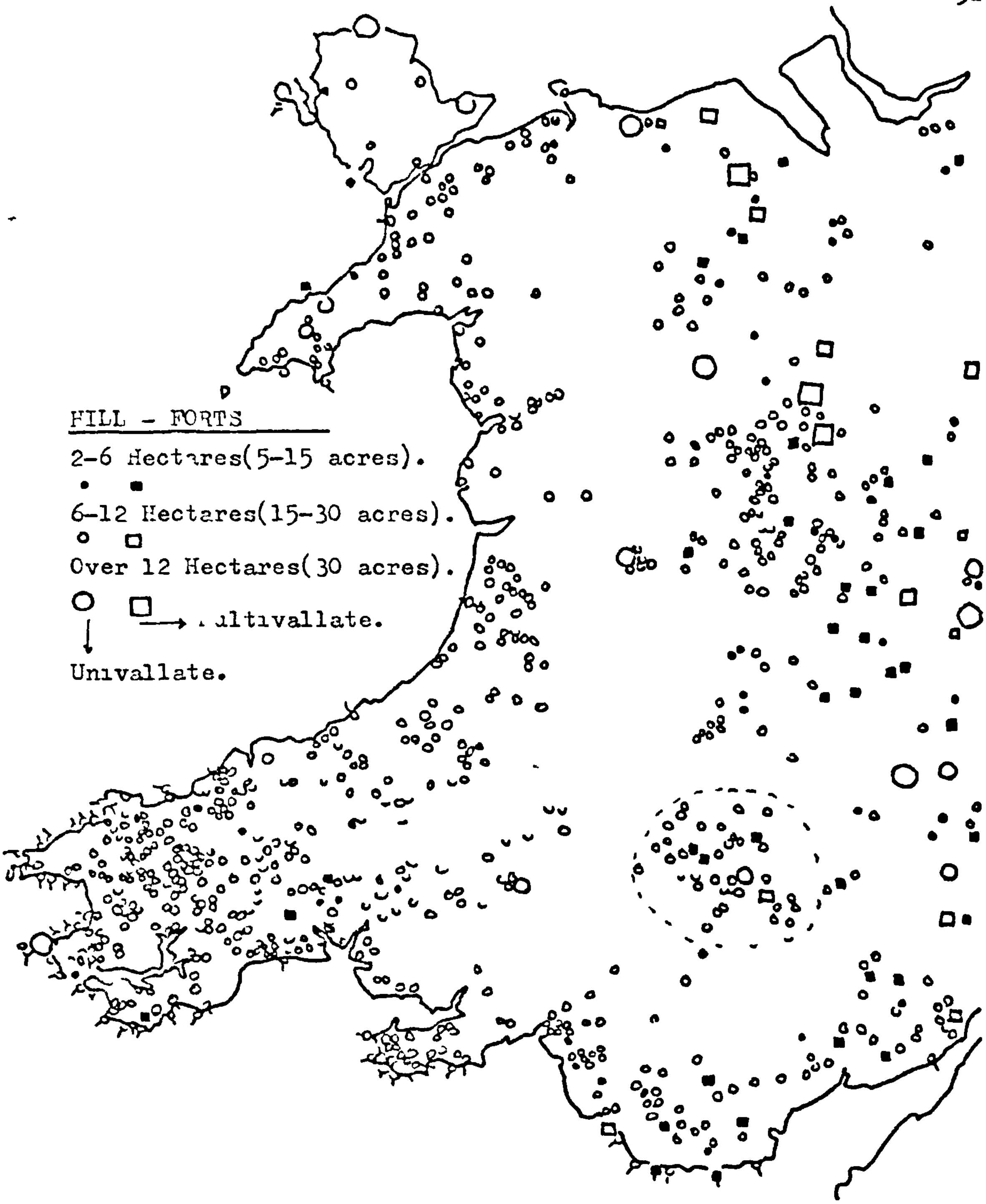


FIGURE 7.2

The distribution of large hill - forts in Wales.

Showing South Breconshire group (including those around the Black-Mountains) .

From Hogg , 1972 .

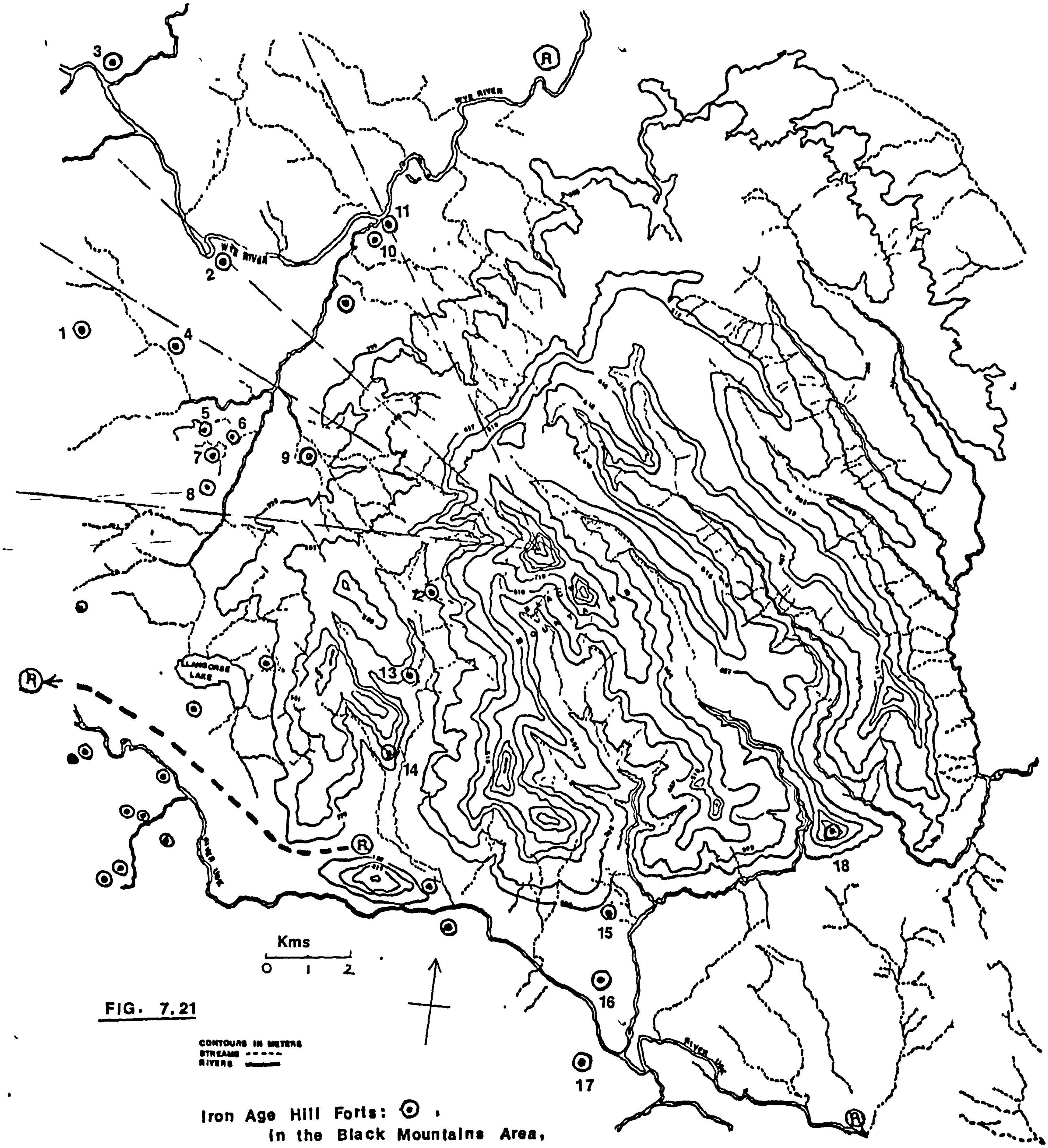


FIG. 7.21

Iron Age Hill Forts: ◉ ,
In the Black Mountains Area,
Breconshire .

Present day existing Roman roads : ▬ ▬ ▬

Roman Forts : Ⓡ .

1. Twyn-y-Gaer
2. Pen Rhiwwen
3. Twyn-y-Garth
4. Pwll-y-Cwru
5. Hillis
6. Llwyfen
7. Drostre
8. Court-y-Gaer
9. Pender
10. Aberlynfi (1)
11. Aberlynfi (2)
12. Castel Dinas
13. Pentir
14. Coed Gaer
15. Crug Hyell
16. Pen Prisk
17. Gaer Llanelly
18. Twyn-y-Gaer

agricultural practices are normally carried out within a 1½ kilometres radius of hillforts. However, forest clearances for grazing are likely to have involved wider areas. The Ty isaf site is 2½ Km. from Castel Dinas which suggests that there could have been extensive clearances and destruction of woodland in this site.

The presence of hill forts with their zones of cultivation are of particular significance when interpreting the pollen picture on those horizons in each profile which correspond in time with hill fort activities . The prevailing winds , as influenced by the mountain ridges and valleys, blow from the Wye lowlands to the west and north-west of the Waun Fach summit . Thus the Waun Fich Central receives pollen predominantly from the area to the north-west , Waun Fach South receives the pollen from the area to the west while Ty isaf is influenced by wind from the west and south which blow directly over the three hill forts mentioned (see section 6.110 , Figure 6.110) .

The Waun Fach North profile presents a different picture . Here the prevailing wind flows from the south up the Grwyne Fawr valley where there is a single hill fort at the mouth of the valley(Twyn-y-Gaer (18),Fig. 7.21). The theory of "pollen shed" by selective pollen-laden winds is discussed in section 6.110 .

The palynological data indicates several intensive and extensive clearances spread over four to five centuries . Waun Fach South records a greater number of intensive clearances than Waun Fach Central and this suggests greater human activity which is confirmed by the archaeological evidence , because the area almost due west has larger and more hill forts than the area to the north-west (see Figure 7.21) .
Thus clearance activities around the hill forts , Pendre , Court - y - Gaer , Drostre , Hillis , Llwyfen and Twyn-y-Gaer are more likely to be recorded on Waun Fach South , (see Table 7.24) .

Pendre is the largest hill fort in the area and is only 6½ Km from Waun F h summit .

It is probable therefore , that clearances around this fort dom inate much of the pollen spectra recorded on Waun Fach South . Waun Fach Centre could well be recording pollen rain from the hill forts areas of Aberlynfi (1)&(2) , Pen Rhiwwen and perhaps Pwll-y-cwru (see Fig, 7.21), but no definite dividing line is evident rather there is an overlapping zone(Fig 7.21,WFS/WFC).

The effect of the Roman occupation probably did have a marked effect on the environment . This included the protracted wars lasting 30 to 70 years Lloyd , J.E. (1954) , the subsequent subjugation of the Silures , the building of Roman forts and garrisons (Fig , 7.21), and the clearing of woodlands for roads . However it is not possible to separate these activities from those of the Silures on the pollen diagrams , with the exception of the Roman "encouragement" for the Silures to grow more cereals and other crops .

One Roman garrison was established at Hay on Wye and road connections passed through the Rhian goll valley . Other Roman roads were connected up to the Talgarth area and down to the fort at Brecon (see Figure 7.21) . The network of roads were necessary for the Romans to govern and facilitated the transport of cereals , wool and timber , Lloyd , J.E. (1954) & Williams, A.H.(1948). The area of pasture land was increased and the production of cereals such as rye , corn and wheat was increased . All these activities modified the environent .

Table 7.22 gives estimates of types of land use inside enclosures . The potential arable land estimates are particularly interesting because they may have been areas supplying ruderals and cereal pollen to the sample site. Table 7.23 indicates the morphological and topographical features of some enclosures. Pendre , the largest hill enclosure is located on the Wye lowlands . Table 7.24 indicates the enclosures which are probably in areas represented by one or more of the pollen profiles .

IRON AGE ENCLOSURE	(i) MARGINAL	(ii) POTENTIAL ARABLE	(iii) ROUGH GRAZING
x Gaer Aberllynfi	25	75	0
x Penffawddog	30	70	0
16 Pen Prisk	15	85	0
17 Gaer Llanelly	10	80	10
x Llangorse	10	60	30
2 Pen Rhiw wen	5	85	10
15 Crug hywel	10	60	30
x Coed Pentwyn	5	75	20
x Penmarth	20	80	-
12 Castell Dinas	5	85	10
9 Pendre	15	85	-
13 Pentir	5	80	15

TABLE 7.22

Enclosure land use in approximate relative proportions for the twelve sites in the Black Mountains area, after Savory H.N. (1950-1951) .

NOTE . x = outside immediate study area .

See Figure 7.21 for location of enclosures .

		Simple Entrance	1Ditch	1 Rampart	2 Ramparts	2 Ditches	Inturned Entrance	Multi-rampart	Multi-ditch	Over 1000 ft.	900 ft. or less	Hill	Spur	Slope
11	ABERLLYNFI GAER 350	x	x	x	-	-	-	-	-	x	-	-	-	-
x	PENFFAWDDOG	x	x	x	-	-	-	-	-	-	x	-	-	x
16	PEN PRISK	x	x	x	-	-	-	-	-	-	x	x	-	-
17	GAER LLANFILLY	x	x	x	-	-	-	-	-	-	x	-	-	x
x	LLANGORSE	x	x	x	-	-	-	-	-	x	-	-	x	-
2	PEN RHIW WEN	x	-	-	x	x	-	-	-	-	x	-	-	x
15	CRUG HYWEL	-	x	-	x	-	x	-	-	x	-	x	-	-
x	COED PENTWYN	-	x	-	x	-	x	-	-	x	-	x	-	-
x	PENYARTH	-	-	-	x	x	x	-	-	x	-	x	-	-
12	CASTELL DINAS	-	-	-	-	-	x	x	x	x	-	x	-	-
9	PENDRE (8 ACRES)	x	x	-	x	-	-	-	-	x	-	-	-	x
13	PENTIR (4 ACRES)	x	x	-	x	-	-	-	-	x	-	-	-	x

TABLE 7.23

MORPHOLOGICAL AND TOPOGRAPHICAL CHARACTERISTICS OF IRON AGE ENCLOSURES IN BLACK MOUNTAINS "AREA"

NOTE : x = outside immediate study area .

See Figure 7.21 for location of the sites .

After Savory H.N. (1950 -1951) .

On the Waun Fach South and Waun Fach Central profiles , extensive clearance activity was recorded between 2100 to 1600 extrapolated years b.p. , and primarily involved in lowland areas (Fig. 6.110). Significant differences between these two profiles do exist . For example (1) , the intensity of clearances differs between profiles , and (2) , the timing of the arboreal clearances and genera cleared often differs between profiles .

Significant Fraxinus regenerations of Waun Fach South (130 - 115 cm) , 2000 to 1800 extrapolated years b.p. , suggest an open woodland situation on rich soils, probably on lowlands areas surrounding hillforts to the west (not found on Waun Fach Centre). The differences in genera cleared suggest that these two profiles , Waun Fach Centre and Waun Fach South represent separate areas .

A significant proportion of the above mentioned clearances were for arable agriculture. This is indicated by the presence of cereal pollen and an increase in Plantago major-media % of T.A.P. , as well as other ruderals indicative of arable agriculture . This has been substantiated by surface pollen data (see sections 3.24). The majority of clearances are generally pastoral.

If the time period for Waun Fach Centre and South are compared to Waun Fach North , (from 120 cm to 75 cm),little resemblance is seen. Waun Fach North shows low levels of clearance with long periods with no clearance at all. This suggests either that clearances were carried out in distant areas such as the mouth area of Grwyne Fawr valley or that clearances were at low levels or a combination of these alternatives (see Figure 6.110) .

A significant clearance phase was recorded at about 1900 extrapolated years b.p. initially in the clearance of Ulmus for arable agriculture probably on low hillsides at the mouth of the valley. Later on Alnus and Betula were cleared in damp open woodlands in the area surrounding the only archeaological site in the valley at Twyn-y-Gaer(Fig 7.?1).The Grwyne Fawr valley has a low arable agricultural potential and few arable clearances are recorded. One of these occured at 1650 years b.p. , on the 85 cm horizon .

Low level clearances are recorded from 1900 years b.p. onwards but constitute little damage to the regenerative potential of the valley flora . Once again the Waun Fach North profile gives valuable information because of the lack of disturbance . The Grwyne Fawr valley is the only area in the Black Mountains region which has no archaeological remains with the exception of the Twyn y-Gaer hill fort which appears not to have been occupied for any great length of time .

The low pastoral and arable potential of this valley makes it a suitable standard control for comparisons with populated areas such as the Rhian goll and the Wye valley lowlands .

On Pen y Gader-Fawr the initial portion of this period involves the closing sequence of a previous large clearance sequence ending with Ulmus and Betula regeneration in a fairly open woodland community on well-drained rich lowland soils on hillsides at the mouth of the Llanbedr valley . The peak woodland regeneration took place approximately 2200 extrapolated years b.p. at the 64 cm horizon .
This was followed by the start of an even longer sequence of clearances of Quercus and later of Ulmus to make way for pastoral agriculture . This is approximately 2000 extrapolated years b.p.

Arable agriculture appeared one century later circa 1900 extrapolated years b.p. (i.e. at the commencement of the Roman period in South Wales) and declined at about 1450 extrapolated years b.p. The Plantago sp. curve indicates increasing clearance activity which peaked at about 1750 extrapolated years b.p. during a period of substantial regeneration of Pinus on well-drained hillsides where grazing pressures had lessened .

In contrast the Ty isaf profile show a clearance peak at about 1830 years extrapolated years b.p. , i.e. earlier than on Pen y Gader-Fawr.

This was probably due to a greater population density and a greater potential for agricultural land . The severity of clearances was greater on Ty isaf , than on Waun Fach South ard Waun Fach Central with Fraxinus making substantial regenerations due to the very open , cleared landscape .

On Waun Fach North and Pen y Gader-Fawr however, the restrictive nature of the valleys for woodland openings is very evident with low background values of Fraxinus. Substantial clearances are recorded on Pen y Gader-Fawr and these may have occured more in areas around the Usk river where the hill forts Pen Prisk and Gaer Llanelly are situated just below Crug Hywel hill forts at the base of the Llanbedr valley

Another means of comparing profiles is to examine other significant genera . The approximate date of the decline in Tilia 's percentages of T.A.P. is an indication of anthropogenic effects as Turner , J. (1964) , suggests . Waun Fach North retains its Tilia T.A.P. levels well into period D .

On Ty isaf Tilia T.A.P. declined at the begining of period D , while Waun Fach South , Waun Fach Central and Pen y Gader-Fawr had long since lost Tilia as a floristic component . The significant regeneration of Tilia on Pen y Gader-Fawr however during 1600 extrapolated years b.p. ownwards indicates a reduction of clearance activities in certain areas of the Llanbedr valley .

This is particularly true also of Ulmus on Waun Fach North at the 75 cm horizon where this genus makes a remarkable regeneration in Betula and Quercus woodlands .

In summary the palynological evidence substantiates historical evidence and shows that a considerable increase in population occured at this period , which resulted in large numbers of woodland clearances . The effects of all this were compounded often causing significant changes . Such changes were most pronounced in the Wye and the Rhian goll valley areas .

The main expansion in clearance activity recorded on the Ty isaf profile started at about 1850 extrapolated years b.p. , and before a similar increase in clearance activity is recorded on the Pen y Gader-Fawr profile.

On both sites , major clearances occured later than in the Wye valley as represented by Waun Fach South and Waun Fach Centre . This means the Palynological record confirms the archaeological evidence .

The number of hill forts in the particular area mentioned in the Wye valley are between 8 and 10 , (depending on distances from Waun Fach) . In the Rhian goll valley there are three hill forts . At the mouth of the Llanbedr valley there is one , and one in narrower Grwyne Fawr valley .

Because there are more hill forts in lowland areas and generally they are larger in size than those in valleys , it is reasonable to assume that the largest population was in the Wye lowlands , followed by Rhian goll and lastly the Grwyne Fawr and Llanbedr valley .

The Roman conquest and occupation influenced conditions in the region in three ways ,

(1) agricultural practices , (2) encouragement of Silures to expand arable agriculture , and (3) the construction of an efficient system of roads for communication ard the transport out of the region of wealth in the form of timber , crops ard wool .

PERIOD A

CORRELATION OF ALL FIVE BLACK MOUNTAINS PROFILES BETWEEN

1500 TO 100 EXTRAPOLATED YEARS b.p.

7.1

These profiles are represented in the following peat horizons .

Site	Peat depth in cm	Radio-carbon years b.p. extrapolated
Waun Fach South	90 to 6 cm	1500 to 100
Waun Fach Centre	75 to 5 cm	1500 to 100
Waun Fach North	75 to 30 cm	1500 to 100
Pen y Gader-Fawr	42 to 14 cm	1500 to 500
Ty isaf	49 to 10 cm	1500 to 300

PERIOD A

7.1 Palynologically a fairly detailed picture of land use emerges covering the period 1500 to 100 extrapolated years b.p. This picture often compliments and augments the historical story of the Black Mountains area . The start of this period on all profiles is marked by a lull or decline in clearance activity which commenced after the Romans left Wales in 383 A.D. Bowen E G. (1977), and continued to the 10th century A.D. (1000 extrapolated years b.p.) .

On Waun Fach North substantial *Ulmus* and *Quercus* regenerations are recorded at the begining of this period (1000 extrapolated years b.p. , 75 cm horizon) .
The regeneration of *Ulmus* indicates that soils are still very fertile . This also suggests that previous *Ulmus* declines may have been due to human activity.

This regeneration was later followed by renewed clearances (up to 65 cm horizon , 1260 extrapolated years b.p.) . As a result *Betula* flourished. Such a *Betula* expansion did not occur on other profiles . These clearances recorded on Waun Fach North were mainly pastoral and probably took place in the entrance of the Grwyne Fawr valley during the 7th and early 8th centuries A.D.

On the Ty isaf profile on the other hand there appears to be little clearance activity between 1500 to 1000 extrapolated years b.p. this is , because Rhian goll valley flora still retained open woodlands with extensive areas of *Alnus* / *Quercus* and *Fraxinus* / *Betula* / *Quercus* woods and/or low T.A.P. for *Plantago lanceolata* and other disturbance ruderals.

The Waun Fach South and Waun Fach Central profiles also show low clearance activity between 1500 to 1000 extrapolated years b.p. These two profiles show palynological similarities to each other with the exception of *Plantago* peak at 500 extrapolated years B.P. (35 cm horizon) which occured on Waun Fach C ntral but not on Waun Fach South(see Figures 6.71 & 6.81).

The Pen Y Gader-Fawr profile differs from the other Black Mountains profiles , because it shows high but declining clearance activity between 1500 to 1000 extrapolated years b.p. These clearances paved the way for considerable Betula growth over previously cleared areas up to 1300 extrapolated years b.p. It is possible that the extension of clearance activity recorded on Pen y Gader-Fawr may have been due to the secluded position of the Llanbedr valley which lies in a backwater or dead end **.

Farmers in the valley were probably untroubled by the petty feuding kings and could extend their farms without let or hinderance . This also suggests that one group or tribe may well have been resident in this valley since Iron age times . This tribe may also have used parts of the old strategic hill fort at Crug hyel . This continuing utilization of Iron age hill forts has been reported before, Savory H.N. (personal communication , (1978). The Waun Fach North profile indicates a similar pattern of Betula regeneration in the Grwyne Fawr valley (see Figures 6.91 & 6.110) .

There is a fundamental difference however in that Ulmus on Waun Fach North has always been a more prominent genus than on Pen y Gader-Fawr . In addition , clearance activities peak at 900 extrapolated years b.p. (50 cm. horizon) on Waun Fach North as compared with no similar Plantago sp. peak on Pen y Gader-Fawr . The hill fort Twyn - y - Gaer may still have bee the tribal centre for the Grwyne Fawr valley (see Figure 7.21) .

** See Figure 6.110 .

SOME HISTORICAL COMMENTS ON THE NORMAN PERIOD

7.12 Following the Norman conquest of England , William I in the 11th century A.D. built a string of castles in England along the Welsh border Williams A.H. (1948). From such castles as Hereford , Gloucester and Monmouth , William's powerful lords spearheaded the attack into the Wye and Usk valley regions , Bowen E.G (1977) .

The subjugation of this area was greatly facilitated by the early establishment of the lordship of Brecon , Bowen E.G. (1977) . The new lordship in Breconshire acted like a little kingdom practically independent of the Crown ,Bowen E.G.(1977).When fighting ceased they secured their position by the construction of wood and later stone castles,Davies D.J. (1933) . They created little walled towns " Bastide " beneath their castles and thus started urban life in Wales , Bowen , E.G. (1977) .

The new lordships introduced a new agricultual economy based on the manorial system . Crop rotation was practiced using the three field system and organic fertilizers were used extensively . Payments of produce were made by the peasant in the Welsheries to the ruling Englisheries, Bowen E.G. (1977) , and Davies , D.J. , (1933) .

CORRELATION OF PALYNOLOGICAL EVIDENCE FROM THE BLACK MOUNTAINS IN WALES FROM 1000 TO 100 EXTRAPOLATED YEARS b.p.

7.13 The approximate date of the resumption or increase in clearance activity on all five profiles (1000 extrapolated years b.p.) was about the time of the Norman occupation of Wales . However the palynological evidence from both the Waun Fach South and Waun Fach Central profiles(between 1000-700 extrapolated years b.p.) shows little to suggest a great expansion of arabl agriculture .

Plantago major-media is only recorded once on each profile. Cereals however do show some increase especially on Waun Fach Central . Total arboreal pollen results for Plantago lanceolata have comparatively low values together with other ruderal indicators .

The apparent contradiction between low clearance activity and high human activity during the " Agrarian revolution " as the Norman period is some - times called, Bowen E.G. (1977) , can be explained in the following manner : the fact that clearances (even low intensity clearances) occured at such widespread localities on both Waun Fach South and Waun Fach Central may be due to one central authority such as a manorial system .

Historically Talgarth an old Welsh capital of Brycheiniog Lloyd J.E (1954), continued to be a centre for the new manorial Englisherie together with nearby Bronllys . The result was more stability in the area . Thus Lloyd J.E. (1954), states " Bernard held Talgarth in his own hands " and later " Miles of Gloucester held Brycheiniog with a firm grips until his death " , in the first half of the 11th century A.D. , Loyd J.E. (1954),(Fig. 7.1).

The main clearance phase on Waun Fach South and Waun Fach North , occured at about 600 extrapolated years b.p. The accompanying sharp rise in

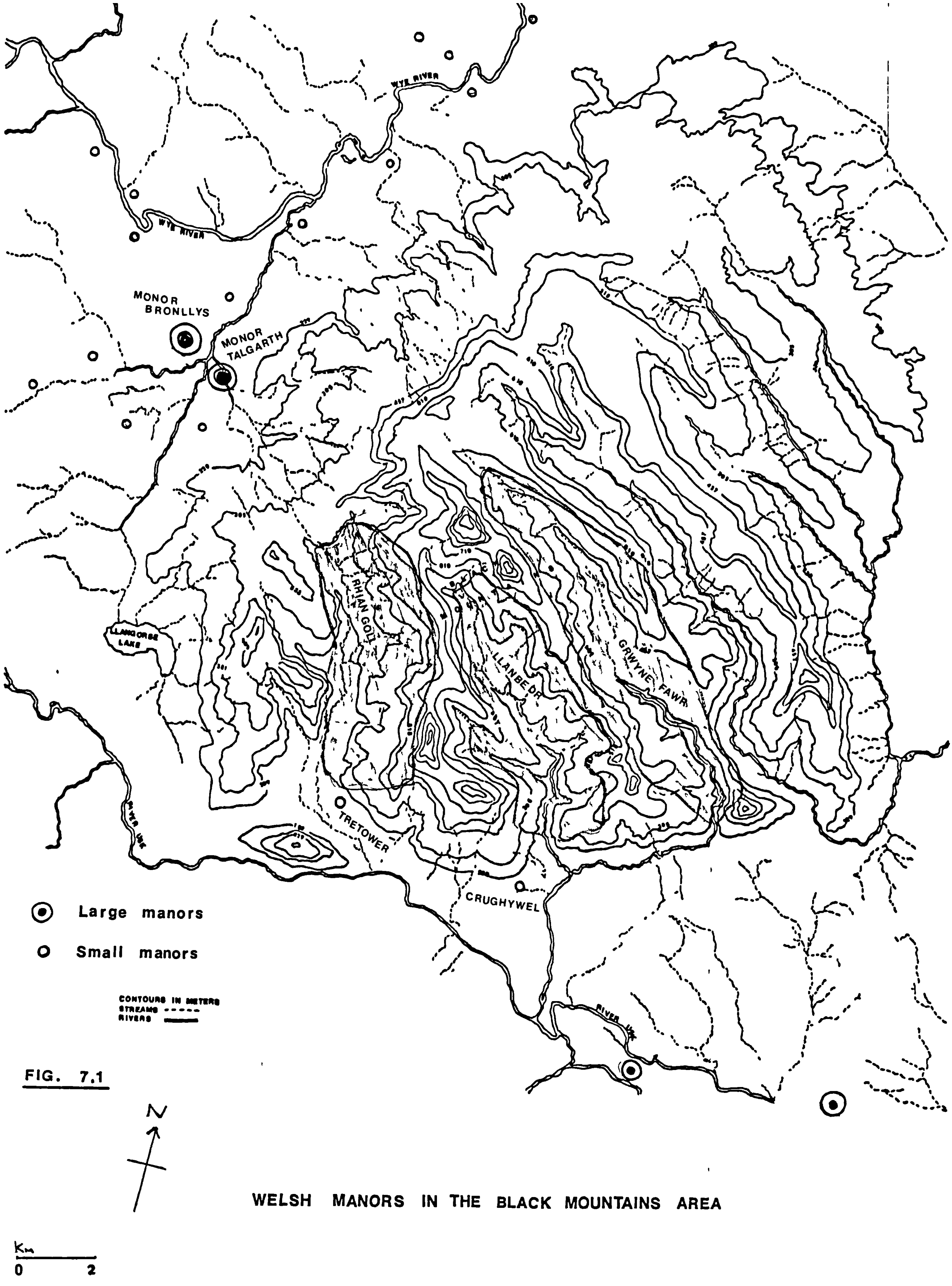


FIG. 7.1

WELSH MANORS IN THE BLACK MOUNTAINS AREA

(From Manors of Wales in the 14th century , after Bowen , E.G. (1977)

PAGE
MISSING
IN
ORIGINAL

Pteridium and Gramineae suggests a local clearance possibly on the north - northwestern foothills on the Black Mountains (see section 6.110) .

The Waun Fach North profile unlike Waun Fach South and Central records very high clearance activity at about 900 extrapolated years b.p. (the 11th century A.D. , 50 cm horizon) . These clearances involve the removal of Betula , Quercus and Ulmus from well drained brown earth possibly on low hillsides at the mouth of the Grwyne Fawr valley (see Fig. 6.110) .

Historically Abergavenny , lying just 7 km south became the centre for the lordships of Gwent in Norman times . The Englisherie almost certainly demanded tribute from the Welshrie in the Grwyne Fawr valley in the form of agricultural produce (e.g. sheep) . This is probably the reason for the increased clearance activity recorded on the Grwyne Fawr valley .

The removal of trees for timber may also be another reason for the expansion of clearances . This would have been particularly true of Grwyne Fawr valley since it had more hardwoods than any other area in the Black Mountains (palynological evidence) . In Norman times Quercus was used to build wooden forts , and was also exported south , Davies, D.J.(1933) .

Perhaps the most surprising fact concerning the period which encompasses the Norman occupation is the apparent absence of human activity as recorded on the Pen Y Gader-Fawr profile . Here clearances appear to have been virtually non - existant except for Plantago sp. peaks at either end of this timescale (1000 to 600 extrapolated years b.p.), (see Figure 6.61) .

The Norman administrative Manor was located at Crughywel (present name is Crickhowell) only 2 km , from the mouth of the Llanbedr valley ** . Presumably the manorial estate had sufficient produce from more productive lowlands in the Usk valley to supply its needs . The lords of the manor may well have used the Llanbedr valley as a hunting preserve as was a common practice in those days , Lloyd J.E. (1954) .

** Lloyd, J.E. (1954) .

The Ty isaf profile in complete contrast to the Pen y Gader-Fawr profile records the most intense clearance activity of any Black Mountains profile at any time . These clearance episodes which include the early portion of the Norman occupation start at approximately 1000 extrapolated years b.p. , and lasted for well over a century .

The recording of extremly high Plantago lanceolata T.A.P. percentages together with high Plantago major-media , Compositae and to a lesser extent cereals , suggest a new era of land use . This very significant pastoral and (to a lesser extent) arable expansion is the best example in the Black Mountains region of the Norman agrarian revolution .

Because these clearance phenomena are not recorded on any other profiles it is probable that they were confined to the Rhian goll valley . If this is the case then the total area involved is relatively small compared to for example the Wye lowlands represented on Waun Fach Central . On the Ty isaf profile the overall picture is one of maximum usage of all available land including marginal areas with steep slopes .

Historically the Rhian goll valley formed the south - eastern corner of Brycheiniog . In Norman times a stronghold of this county lordship was located in this valley at Ystrad Yw (Lloyd J.E. 1954) , (exact location unknown) . The small size of the valley must have faciliated supervision of the Welshries .

The substantial increase in clearances with the consequent increase in agricultural yields made it possible to provide adequately for the Welsh farmers and their fuedal lord . There then followed a period when clearances declined (cereal % of T.A.P. increased?) to a low at the 20 cm horizon . This could have been due to drastic reductions in population caused by the Black Death in 1348-49 followed by a series of plagues, Davies D.J. (1933) .

During this period the population of Wales became halved , agriculture neglected and trade stagnated , Davies . D.J. (1933) . These events together with Glyndwr's revolt (in which he devastated manors , destroyed crops and burnt buildings) contributed to the decay of the manorial system as an economic unit , Davies . D.J. (1933) .

Also , the manor at Ystrad Yw is not recorded in the 14th century maps of Wales , and , may have been abandaned , which is consistant with the lull in clearance (see Figure 7.1) . It may be that the administrative centre had moved to Talgarth or Trecastell (present name , Tretower) , Lloyd . J.E. (1954) , or that Llywelyn destroyed the manor (Ystrad Yw) when he conquered it in 1262 A.D. Lloyd, J.E. (1954) .

Clearances remain steady from the 14 cm. horizon upwards (420 extrapolated years b.p.) to the end of the profile at 300 extrapolated years b.p. During this time pastoral clearances predominate .

In marked contrast to the Ty isaf profile , the Pen y Gader - Fawr profile exhibits much greater clearance activity from 620 to 480 extrapolated years b.p. This is interpreted as a response to a fast growing population.

The Waun Fach North profile shows that after the clearance peak at 900 extrapolated years b.p. , clearances steadily declined over a long period until the middle of the 15th century (500 extrapolated years b.p.) . Again this decline may have been partly due to the series of plagues (circa 630 years b.p.) , Davies D.J. (1933) .

In the mid 16th century clearances increase as a response to population pressures even in remote valleys . After this time only two profiles , Waun Fach South and Waun Fach Central have palynological information from the mid 17th century onwards . The Waun Fach South profile shows an earlier increase in clearance activity at about 330 years b.p. (extrapolated) onwards .

This is compared to a similar increase on Waun Fach Centre occuring slightly later at the start of the 18th century . The closeness of dates and the remarkably similar Plantago values between profiles suggest the start of this activity is synchronous . The intensification of clearance activity appears mainly on lowland areas and once again is probably a response to the population pressures .

Historically these periods between 17th to 19th centuries on both profiles encompass the land enclosures of the 18th century, Davies D.J. (1933) . A reduction in the age of consent , Howells, B. (1977) , and increased longevity of the peasant , Howells, B. (1977) , all helped to increase the Welsh population from 342,000 in 1670 to 542,000 in 1801 ** .

The Napoleonic wars cut imports of grain from the U.S.A. and thus created increased demand for cerial production . As a result more of the marginal lands and poor upland areas were utilized for cereal production . According to Thomas , D . (1963) , there was an improvement in climate at this time (19th century) which made it possible to produce cereals at higher altiudes .

** Howells , B. (1977) .

APPENDIX

APPENDIX 1.1b

COUNTY NAME CHANGES USED IN THIS THESIS

Brecknockshire as a county dates from an act of union in the reign of Henry VIII , being one of five shires carved out of what had been the " lands of the Lords Marches " .

Approximately , 1000 years earlier it had become the kingdom of Goided Prince Brychan and from him took its name more recognisable in the Welsh name Brycheiniog (Brecknockshire being the English version of Brycheiniog) .

The county was later called Breconshire with the town of Brecon being the capital . Today the county is called Powys and encompasses most of the Black Mountains and environs to the north and west . Just south of the Black Mountains is Mid - Glamorgan and to the east is Hereford and Worcester in England.

APPENDIX 6

ABBREVIATIONS USED IN THIS THESIS

T.P. : Total pollen .

T.R.P. . Total ruderal pollen .

T.H.P. : Total herb pollen (Gramineae etc.) .

T.A.P · Total arboreal pollen .

Pl. l. : *Plantago lanceolata* .

Pl. lan. . *Plantago lanceolata* .

Pl. maj/med. . *Plantago major-media* .

Pl. m.m. · *Plantago major-media* .

Years b.p. : Years before present (uncorrected years) .

P.Y.G.F. . Pollen profile from Pen y Gader Fawr mountain .

W.F.S. : Pollen profile from Waun Fach South .

W.F.C. : Pollen profile from Waun Fach Central .

W.F.N. . Pollen profile from Waun Fach North .

Zone P - 4 . Pen y Gader-Fawr profile zone, 4th zone from base.

Zone T - 2 . Ty isaf profile zone, 2nd zone from base.

Zone S - 2 . Waun Fach South profile zone, 2nd zone from base.

Zone C - 5 : Waun Fach Central profile zone, 5th zone from base.

Zone N - 8 . Waun Fach North profile zone, 8th zone from base.

m : Metres .

Km : Kilometres .

Cm . Centimetres .

TABLE 6.2

APPENDIX 6.2

PLANT INDICATORS OF FLORISTIC DISTURBANCES , SUCCESSION , HUMAN ACTIVITY, etc.

Rumex

grows in exclusively open habitats*.

Artemisia

the above genera can indicate cultivation of ground when in association with Plantago sp. or Compositae . Combinations of the above four with increasing Gramineae and herbs can be anthropogenic*.

* Pennington W . (1969) .

Tilia

decline in Tilia can indicate selective felling , Pennington W. (1969) .

Pteridium

it s increases with Fraxinus increasing , may indicate local openings in the forest canopy.**

Fraxinus

often increases after clearances.**

Betula

is similar to Fraxinus , but reaches peak before Fraxinus.**

Fraxinus

representing its temporal position in successional sequences that is following Betula**.

Betula

needs light for its seedlings to germinate**.

<u>Betula</u>

often shows an increase after clearances or opening in woodlands, and therefore, can be an indicator of disturbance.**

** Moore P.D. & Bellamy D.J., (1974).

<u>Plantago lanceolata</u> and Gramineae

temporary rises in these two species indicates pastoral farming, Walker M.P. & Taylor J.A. (1976).

<u>Taraxacum type & Rumex</u>

are indicators of human activity, Walker M.P. & Taylor J.A. (1976).

<u>Plantago major - media</u>

a rise in this species with Chenopodiaceae, <u>Taraxacum</u> type and <u>Artemisia</u>, is associated with cereal pollen, Walker M.P. & Taylor J.A. (1976).

<u>Plantago lanceolata</u>

when present, can indicate pastoral economy, Turner J. (1964).

<u>Plantago major - media</u>

when present, can indicate arable agriculture, Turner, J. (1964).

Gramineae

with <u>Plantago lanceolata</u> and <u>Rumex sp.</u>, indicate pastoral clearances, Waterbolk H.T. (1958).

<u>Pteridium</u>

curve behaves like <u>Plantago lanceolata</u>, therefore like the latter species, <u>Pteridium</u> can be a pastoral indicator, Moore P.D. & Chater E.H. (1969).

Gramineae

peak when present , with cultural herb indicators , suggests clearance , Turner J. (1971) .

Pteridium

spores reflect fairly open woodland , Turner J. (1965) .

Gramineae

and Plantago , represent areas of clearings, Turner J.(1965).

High Pteridium T.A.P. with

Plantago lanceolata indicates pastoral clearances , Turner J. (1965) .

Compositae

Rumex , Chenopodiaceae indicate arable agriculture , Turner J. (1965) .

Taraxacum type

Chenopodiaceae , Compositae , Carduus / Cirsium type , when in abundance , suggests arable agriculture or cleared ground , Merryfield D. (1977) .

Ulmus

if declines , and Gramineae increases with Plantago lanceolata , this suggests clearances by pastoral agriculture , Smith A.G. and Willis E.H. (1961 - 1962) .

The " Ulmus " decline

suggests utilization of Ulmus leaves for cattle fodder , Troels - Smith J. (1956) .

<u>Ulmus glabra</u>

requires a base rich in mull soil for regeneration , Pennington W . (1969) .

<u>Ulmus</u>

cannot regenerate on soils already impoverished by leaching , Pennington W. (1969) .

<u>Plantago lanceolata</u>

occurring as <u>Ulmus</u> curve falls , suggests that <u>Plantago lanceolata</u> is associated with man's activities, Pennington W. (1969) .

<u>Alnus</u>

grows in wet hollow gulleys , stream edge or river banks , Pennington W. (1969) .

<u>Alnus</u>

is more abundant in valleys than on hills , Moore P.D. and Bellamy D.J. (1974) .

<u>Tilia</u>

often flourishes in undisturbed area (e.g. valleys) . The greater the proportion of Tilia , the less disturbances , Moore P.D. (1977) .

<u>Tilia</u>

decline in Iron age is associated with human activity , Moore P.D. (1977) .

<u>Tilia</u>

is often associated with base rich mor humus , Moore P.D. , (1977) .

Polypodium

has a Betula arboreal habitat , Smith R.T. & Taylor J.A. (1969) .

Corylus

young shoots are not eaten by cattle , Bradley R. (1978).

Clearance phases

are indicated by non arboreal pollen increases , together with rises in the values of Gramineae , Plantago lanceolata " weed " genera and Pteridium spores , Hicks S.P. (1971) .

Fall in T.A.P.

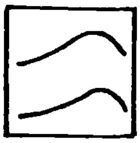
is associated with increase in clearance indicators , Walker M.P. and Taylor J.A. (1976) .

APPENDIX 6.4

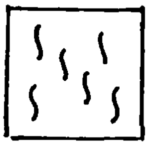
STRATIGRAPHIC SYMBOLS

USED ON FIGURES 6.51,6.61,6.71,6.81,6.91

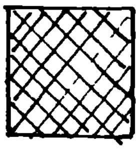
Sphagnum peat



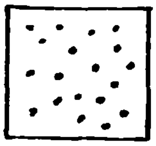
Eriophorum peat



Amorphous peat with monocotyledon remains

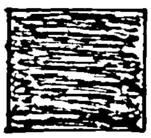


Sand



Eriophorum peat with substantial amounts of Sphagnum

Charcoal



STRATIGRAPHY OF THE TY ISAF PEAT PROFILE

TABLE 6.5

cm	
0 - 81	Poorly - humified *Eriophorum* peat with abundant root penetration in upper horizons of *Eriophorum* and some *Vaccinium* roots ; some *Sphagnum* leaf fragments .
27 - 43	Moderately-humified *Eriophorum* peat , occasional *Polypodium* spores and *Succisa* and woody *Eriophorum* root fragments . *Juncus* capsules in upper layers .
43 - 56	Moderately - humified *Eriophorum* peat with abundant leaf fragments of *Sphagnum sp.*
56 - 62	Poorly - humified *Eriophorum* peat with *Eriophorum* root fragments and *Succisa* spores and some *Sphagnum sp.* leaf fragments .
62 - 72	Monocot peat with *Eriophorum* root fragments . *Polypodium* and *Succisa* increasing with depth . Highly silicious .
72 - 78	Monocot peaty sand , some *Eriophorum* root fragments , low organic content . Highly silicious .
78 - 81	Charcoal layer .
81 +	Sand .

STRATIGRAPHY OF THE PEAT PROFILE FROM PEN Y GADER - FAWR

TABLE 6.6

cm	
0 - 29	Poorly-humified _Eriophorum_ peat with abundant _Sphagnum_ remains , _Eriophorum_ roots . Some silicious downwashed from summit , and few fungal spores .
29 - 38	Moderately humified _Eriophorum_ - _Sphagnum_ peat with _Succisa_ some _Juncus_ capsules and fungal spores .
38 - 57	Moderately humified _Eriophorum_ peat , some Sphagnum leaf fragments, _Succisa_ , few _Juncus_ capsules , few Carex nuts and fungal spores .
57 - 62	Moderately humified _Eriophorum_ - _Sphagnum_ peat , with many _Succisa_ .
62 - 85	Moderately humified _Eriophorum_ peat with Carex nuts , _Succisa_ , and _Juncus_ capsules .
85 - 90	Moderately humified _Eriophorum_ - _Sphagnum_ peat with many _Succisa_ .
90 - 105	Moderately humified (humification increasing with depth) _Eriophorum_ peat with some _Sphagnum_ leaf fragments . _Succisa_ , incresing in number with depth , some Carex nuts , _Polypodium_ spores and a few fungal spores .
105 - 116	Alternating monocot peat and thin silicious lenses . Large numbers of _Polypodium_ spores and _Succisa_ .
116 +	Sand with very low organic content and poor preservation of spores.

STRATIGRAPHY OF THE PEAT PROFILE , WAUN FACH CENTRAL

TABLE 6.7

cm	
0 - 55	Poorly-humified _Eriophorum_ peat with up root penetration in upper horizons some _Sphagnum_ leaf fragments. Occasional Carex nuts .
55 - 120	Moderately humified _Eriophorum_ (and _Sphagnum_) peat with many _Juncus_ capsules and Rhizopods. Many fragments of _Eriophorum_ roots .
120 - 132	Moderately humified _Eriophorum_ peat with _Juncus_ capsules .
132 - 148	Poorly-humified _Eriophorum_ peat with _Eriophorum_ root fragments .
148 - 177	Well humified _Eriophorum_ and _Sphagnum_ peat with _Juncus_ capsules and Carex nuts .
177 - 215	Moderately humified _Eriophorum_ peat with a profusion of _Juncus_ capsules.
215 - 237	Well humified _Eriophorum_ peat with _Polypodium_ spores and Carex nuts.
237 - 244	Amorphous monocot peat highly silicious with _Succisa_, _Polypodium_ spores with _Juncus_ capsules .

STRATIGRAPHY OF THE WAUN FACH SOUTH PEAT PROFILE

TABLE 6.8

cm	
0 - 34	Poorly-humified *Eriophorum* peat with some *Sphagnum* peat . *Eriophorium* root penetration .
34 - 70	Moderately-humified *Eriophorum* peat , few *Eriophorum* root fragments, some *Juncus* capsules . Scattered highly humified bands .
70 - 140	Well-humified *Eriophorum* peat , large quantities of *Sphagnum* . *Eriophorum* root fragments , *Juncus* capsules and some Carex nuts .
140 - 158	Poorly-humified *Eriophorum* peat and some *Polypodium* spores .
158 - 201	Moderately-humified *Eriophorum* peat with *Sphagnum* fragments increasing with depth . *Polypodium* spores abundant , with some *Carex* nuts , *Juncus* capsules and
201 - 214	Moderately-humified *Eriophorum* peat , *Polypodium* spores abundant , and *Eriophorum* root fragments .
214 - 227	Well-humified *Eriophorum* peat with *Polypodium* spores .
227 - 234	Amorphous compacted dark brown monocot peat.Some silicious material present .
234 - 250	Amorphous very dark brown monocot peat , highly silicious abundant *Succisa*, Polypodium spores .
251 +	Coarse silica grains , low organic content .

STRATIGRAPHY OF THE WAUN FACH NORTH PEAT PROFILE

TABLE 6.9

cm	
0 - 29	Poorly humified *Eriophorum* peat with *Sphagnum* leaf fragments . Surface root with penetration in upper layers .
29 - 45	Moderately humified *Eriophorum* with several fragments of *Eriophorum* roots. Occasional Carex nuts and some *Sphagnum* leaf fragments . *Juncus* capsules decreasing with increasing depth .
45 - 87	Poorly humified *Eriophorum* peat , with occasional *polypodium* spores.
87 - 110	Moderately humified *Eriophorum* peat , some *Juncus* capsules and fungal remains .
110 - 145	Moderately humified *Eriophorum* peat with lenses of *Sphagnum* peat , *Eriophorum* root remains . Carex nuts , *Polypodium* spores and Rhizopod fungus .
145 - 160	Moderately humified *Eriophorum* peat with very occasional *Sphagnum* leaf fragments . There are few *Polypodium* and *Succisa* .
160 - 219	Well humified Eriophorum peat with several *Juncus* capsules some Carex nuts , *Polypodium* spores and increasingly silicious at lower horizons .
219 - 230	Amorphous humified monocot peat with *Juncus* capsule , *Succisa*, and *Polypodium* spores , highly silicious .

APPENDIX 7

POLLEN CHARACTERISTICS OF THE ZONES FROM TY ISAF (PEN TRUMAU)

DEPTH IN CM.

72-70 — Elm increasing rapidly from 4-11% T.A.P. Lime declining from 21-14% T.A.P. Alder declines slightly. Hazel rises slightly then declines marginally. Plantago not present. Gramineae and Ericaceae low and sporadic levels. Increasing tree pollen.

670 — Elm peak, no Plantago sp. Tree pollen peak.

70-66 — Rapid rise in oak peaking at 69 cm horizon with 60% T.A.P. from 20% T.A.P. then sharp decline, slight recovery then declining at 1st Plantago. Plantago lanceolata peak at 66 cm horizon. Alder has a sharp jagged rise. Birch continues to decline before rising sharply only depressed slightly by Plantain peak. Hazel levels peak but decline at 66 cm Gramineae up slightly. Ericaceae sharp increase and peak in at 66 cm, Lime declines rapidly. Total tree pollen levels down on average. Elm declines before plantago then recover slightly and declines.

T-1

66 — Plantains first peak. Elm & Lime not registered. Oak down to about 15%. Highest Alder peak. Hazel slightly depressed. Ericaceae just below 200% T.A.P. Gramineae very low.

66-60 — Sharp decline in plantago followed by even sharper increase in Plantago lanceolata. Birch increases greatly. Oak first peaks in at 1st Plantain peak then increases faster. Alder declines throughout. Elm regenerates partially with Pine but declines as Plantago increases. Hazel rises sharply at 2nd Plantain peak. Gramineae substantially increases. Ericaceae also sharply increases.

T-1

60 — High Plantago lanceolata peak. No Elm or Oak increases. Alder slightly down. Birch increases sharply. Hazel Gramineae Ericaceae peak. Ruderals peak.

60-49 — Plantago lanceolata continues to rise to peak at 58 cm then slowly declines to low at 49 cm, with Plan major-media. Elm regenerates slightly after Plantain peaks declining at upper horizons. Birch continues to make large increases peaking at 50 cm, with 76% T.A.P. declining marginally afterwards. Pine sporadic and low occurence. Oak peaks with plantain declines and partially regenerates at 49 cm Alder declines slowly peaking just before birch peak then declining sharply. Fraxinus peaks after Plantain main peak but declines slowly towards49 cm. Hazel declines rapidly throughout zone. Gramineae and cereal: peaks with both

DEPTH. IN CM.	
T-1	Plantain peaks at 58 and 55 cm but after declines sharply. Ericeae declines sharply after 1st Plantain peak then climbs very sharply (700% T.A.P.) at 2nd Plantain peak and then rapidly declines.
49	Birch peak Plantago low, Elm low, Quercus low. Alder low, Hazel low.
49-44	Increase in Plantago peaking(smaller) at 44 cm. Elm regenerates between plantago. Birch initially drops sharply but peaks again at 44 cm Oak peaks twice one quite large before 44 cm the second smaller on 44 cm horizon. Alder increases sharply, slightly declines before lesser peak at 44 cm Fraxinus reappears with peak at 44 cm Hazel makes broad peak before 44 cm horizon. Gramineae very low. Ericaceae partially recovers reaching about 300% T.A.P.
44	Plantain peak. Elm and Oak low. Alder depressed. Birch partly recovers. Hazel slightly down. Gramineae low, Ericaceae low.
44-40 T-2	Plantago declines but peaks at 40 cm, Elm not represented except at 44 cm Birch sporadic but overall declines. Oak peaks mid-zone but declines at 40 cm Alder increases peaking at 40 cm Fraxinus peaks after Plantago at 43 cm then declines. Hazel increases slightly. Gramineae peaks mid-zone. Ericaceae declines from 200 to 100% T.A.P.
40	Plantain peaks, Oak and Birch decline slightly. Alder peaks. Gramineae and Ericaceae both low.
40-38	Plantago decreases but then has a small peak at 37 cm. Birch peaks mid-zone together with elm. Oak makes a significant mid-zone peak before declining sharply at 37 cm. Alder declines mid-zone but rises. Fraxinus once again peaks after Plantain peak. Hazel peaks, declines then increases marginally. Gramineae peaks mid-zone while Ericaceae has a major peak on upper horizon.
38	Plantago lanceolata peak, Elm low, Oak and Alder comparatively high. Birch depressed, Hazel marginal peak. Large peak for Ericaceae and low for Gramineae Trees and Shrub T.P. significantly down.
34 T-3	Dramatic rise in Plantago lanceolata up from 10 to 187% T.A.P. Oak declining sharply then climbs sharply with Plantain. Alder peaks before plantain. Birch does same as Alder but peaks earlier. Elm sporadic but peaks on Plantain peak. Hazel declines sharply but recovers at Plantain peak 34 cm horizon. Gramineae and Cereals increase dramatically while Ericaceae fall rapidly. Pteridium rises sharply. Tree and shrub level low.

	DEPTH. IN CM.	
	34	Highest plantain peak of diagram. Oak and elm recovering. Alder and birch declining. Gramineae and cereals peak. Tree and shrub levels low.
T-3	34-30	Plantago lanceolata declining sharply but Plantago major-media levels unchanged. Oak has very largemid-zone peak. Pine reappears and remains fairly constant. Elm declines initially but regenerates at 30 cm Alder declines steadily with slight regeneration before dipping towards 30 cm horizon. Fraxinus reappears then slightly declines. Birch continues to fall but at mid-zone climbs steadily to 30 cm. and peaks. Hazel very steady depressing slightly at 30 cm. Gramineae depresses mid-zone then climbing sharply. Ericaceae climbing very dramatically to 600 T.A.P. and declining just as fast to about 200% T.A.P. Great increase in ruderals. Ilex present at two levels.
	30	Regeneration of Elm and Pine. Depression of Oak and Alder. High peak in Birch. Rise in total Tree andShrub pollen.
T-3	30-25	Plantago falls , Quercus rises , Betula falls. Alnus increases , ruderals and Gramineae decreases. Pinus rises at 25 cm and Fraxinus peaks .
T-4	25-18	Plantago peaks at 19 cm and falls at 18 cm , together with Gramineae and ruderals . Quercus rises , Alnus falls, Fraxinus falls .
T-5	18-14	Sharp decline in Plantago corresponding to regeneration of Ulmus and Pinus . Quercus increases , Alnus decrease . Betula and Corylus unchanged. Gramineae decrease, Ericaceae marginal increase .
	14	Strong Ulmus peak . Depressed TAP plantains . Quercus high , low Alnus .
	14-10	Sharp rise in Alnus with depression in Quercus , slight depression in Betula, Increase in Corylus . Slight rise in Gramineae , but a sharp rise in Ericaceae .

APPENDIX 8

POLLEN CHARACTERISTICS OF THE ZONES OF

PEN y GADER-FAWR

Zone	DEPTH. IN CM	
	116-111	Plantago peak at 111 cm; Elm increasing, Lime and Oak and Alder declining. Pine peak, Hazel declines, Ericaceae and Gramineae decline.
	111	Plantain peak; Oak, Lime and Alder decline. Elm increasing.
P-1	111-100	Elm increases and peaks, Plantago declines, Oak increases, Lime declines, Birch initially falls and then increases. Hazel initially declines, peaks then declines. Ericaceae sharply increases, Gramineae decreases.
	100	Elm peaks, Plantago declines, Ericaceae increase, total tree pollen as percentage T.P.
	100-92	Plantago reappears and climbs, Elm declines, Oak increases sharply then declines sharply. Lime increases; Alder initially increases then declines; Birch increases then declines; Ericaceae and Gramineae climb; Ruderals significantly increase.
	92	Elm low, Plantain high. Oak decreases; Alder increases, Ericaceae climbing, Hazel declining, total tree pollen as percentage of T.P.
	92-87	Plantago climbing increases and peaks. Alder increasing, Lime and Birch declining, Hazel declining. Ericaceae and Gramineae slightly declining. Elm declines.
P-2	87	Plantago climbing, Lime low, Oak high, Alder climbs. Birch declining. Elm not recorded, Hazel declines, Gramineae and Ericaceae declining.
	87-83	Plantago increases and peaks, Birch declines and is not recorded. Oak declines, Alder increases. Ericaceae and Gramineae increasing.
	83	Major plantain peak. No Elm or Birch recorded. Alder peak, Hazel declines, Ruderals increase.
	83-71	Plantago declines, Oak climbs, Lime peaks at 70 cm Alder declines, Hazel increases. Ericaceae declines, Gramineae increases
	71	Oak peaks, Plantain low, Lime peak, Alder down, Birch low, Elm increasing.
	71-64	Elm climbs and peaks, Birch climbs and peaks, Plantago sp. declines, Oak increases then declines, Alder declines, Hazel increases, Ericaceae and Gramineae decreases.

DEPTH. IN CM	
64	Elm and Birch peaks, Alder increases. Plantago lanceolata declining, Oak increasing. Total tree pollen peaks as a percentage of T.P.
64-59	Plantago lanceolata increases, Oak increases, Alder decreases. Elm decreases, Birch decreases. Gramineae increases dramatically, together with cereals, ruderals increasing.
59	Plantago increases, Elm decreases, Ruderals increase. Total tree pollen as percentage of T.P.decrease. Gramineae peaks. Pine peaks.
59-51	Plantago lanceolata increases and peaks. Elm declines and is not present. Birch peaks, Oak declines, Alder declines, Hazel and Pine declines. Ericaceae increases and Gramineae peaks. Ruderals peak before plantains.
P-3	
51	Highest plantago peak of profile, Birch peaks, Gramineae high.
51-43	Elm reappears at 43 cm. plantago declining, Birch increasing, Oak decreasing; Alder decreasing.
43	Elm peaks, Plantago declines, Hazel, Oak and Alder declining. Gramineae peak.
43-38	Birch increases and peaks, Elm declines, Plantains continue to decline. Elm and Oak levels very low at 38 cm, Alder declines, Ericaceae increases.
38	Largest Birch peak, smallest Oak value; Plantago still declining, Ericaceae peaks.
38-34	Elm increases and peaks, Birch low, Plantain low, Oak and Lime increase and peak at 33 cm. Alder increases.
34	Elm peak, Ericaceae, Gramineae and Plantago have lows.
34-30	Plantago increases and peaks, Elm declines, Oak declines, Hazel, Birch and Alder increase, Ericaceae increases and Gramineae peaks.
P-4	
30	Plantain and Gramineae peaks and Ruderals increase. Elm declines.
30-22	Hazel continues to increase and peak. Plantain and Elm fade and not recorded, Pine increases and peaks, Oak and Alder initially increase. Gramineae decreases to a low at 22 cm. Ericaceae increases. Birch increases and peaks at 22 cm
22	Birch peaks, Pine peaks, Oak and Alder declining; total tree pollen and total shrub pollen peak as percentage T.A.P.

DEPTH. IN CMS.	
↓22-14 P_5 ↑	Birch and Hazel declines, <u>Plantago</u> rises sharply, Oak initially increase then decreases sharply, Alder initially drops then climbs sharply. Pine and Lime declines then reappears. Ericaceae increases, Gramineae initially increases then decreases.

APPENDIX 9

POLLEN CHARACTERISTICS OF THE ZONFS FOR WAUN FACH CENTRE

DEPTH. IN CMS.		
C-1	244-238	Plantago lanceolata increasing to a peak at 238 cm Elm erratic but declines on 238 cm horizon. Phenominal rise and peak in Betula 76% T.A.P. Oak an initial increase but then steep decline. Lime levels on slight decline. Alder also declining. Fraxinus peaking just before Plantains peaks. Hazel steadily declining. Ericaceae and Gramineae both decreasing.
	236	Birch peak 76% T.A.P. Plantain peak, high tree and low shrub total pollen percentages.
	238-231	Sharp decrease in birch. Sharp climb in elm, alder, oak and to a less extent lime. Sharp increase in Hazel. Increase in Gramineae .
	231	Elm peak. Oak down slightly. Alder up slightly. Lime on the increase. Birch down slightly. Sharp increase in Hazel. Ruderals down.
C-2	231-226	Elm drops sharply then regenerates to peak at 225 cm horizon. Lime rises constantly except at top of zone. Alder suffers a mid-zone depression. Fraximus peaks just before 225 cm horizon. Birch remains fairly stable. Hazel suffers a mid-zone fall but recovers. Ericaceae and Gramineae up significantly.
	226	Elm peak, high Alder and Oak, Lime and Fraxinus declines. Ericaceae and Gromineae declining slightly.
C-3	225-219	Plantain peak at 219 cm Elm declines sharply. Oak decreases significantly and Alder increases by a similar magnitude. Birch unchanged. Ericaceae drops whereas Gramineae climbs marginally. Hazel down.
	219	Plantain peak Alder up Quercus down. Ruderals down. Tree total up.
C-4	219-204	Elm initially recovers but not to former levels and then declines at upper boundary (204 cm). Plantain and Pteridium fall slightly but peak at 204, (Pl.lan. 14% T.A.P.). Quercus rises sharply with a partial setback on the upper boundary. Birch rises marginally, Alder makes slight losses. Fraxinus not registered on upper Plantain peak. Ericaceae rises marginally on upper boundary and Gramineae has a sharp increase initially tailing off slightly at 204 cm but up on 219 cm horizon. Hazel has mid-zone increase.

	Depth in cm	
	204-194	Both Plantago and Betula peaks decline , Ulmus regenerates. Ericaceae and Gramineae decline.
	194-190	Ulmus declines as clearances decline . Weeds low , T.T.P. peak .
C-5a	190-174	Increase in Ulmus. Mid-zone peak of plantago. Oak increases, Alder declines. Fraxinus peaks at174 cm with Ulmus. Hazel declines steadily. Ericaceae has a high peaked mid-zone distribution.
	174	Quercus peak, Plantain low, Quercus increases, Alder increases. Fraxinus peaks. Hazel total Tree pollen peak.
C-5b	174-166	Clearance phase in Elm from 9 to 2½ T.A.P. with corresponding rise in Oak, slight rise in Birch and slight fall in Alder. Corylus rises sharply from 58 to 128% T.A.P. Plantago sp. not registered. Return and regeneration of Fraxinus. Ericaceae continues to decline sharply whereas Gramineae rises sharply from 15 to 60% T.A.P.
	166	Elm low Plantain reintroduced, Quercus increases. Alnus declines, Birch increases, Hazel climbs and Fraxinus peaks.
	166-158	Plantago increases and peaks at 158 cm Initial increase in Oak, declining at 158 cm Alder increases steadily. Birch decreases, Hazel mid-zone peaks. Ericaceae increases, Gromin decreases.
	158	Plantain peak. Elm low. Quercus declines, Alder decreases, Birch reduces, high ruderals.
	158-150	Rapid plantain decline Elm peak,Oak declines. Alder increases, Fraxinus peaks, Birch rises, Hazel declines. Gramineae strong decline. Ericaceae mid-zone depression.
	150	Elm peak, Plantain low, Fraxinus peaks, Pine reappears. Gramineae strongly declines. Peak in total tree pollen as percentage of total pollen.
C-6	150-140	Elm levels drop marginally 8 to 6½ T.A.P., Oak initially increases but later decreases significantly. Birch continues to increase. Alder decreases initially but increases slightly on upper boundary. Fraxinus declines till unrecorded. Corylus increases sharply from 67 to 148% T.A.P. Ericaceae continues to increase with a peak mid-zone and finishing back to initial zone level. Gramineae begins to increase rapidly doubling from under 10% to over 20% T.A.P. Ruderals increase on upper boundary.

DEPTH. IN CM.	Zone	
140		Depression in total tree pollen as percentage of T.P. shrub peak. Elm high plantain low, Oak declines Alder high, Hazel high, Birch high. Falling Ericace e increasing Gramineae .
140-110	C-6	Continuing slow building up in Plantago lanceolata peaking at the 110 cm. horizon. Elm declines reappears then falls and reappears with low levels at Plantain peak. Birch increases steadily peaking at 110 cm. Oak very erratic with a series of peaks and troughs down at 110 cm. Undulating decrease in Alnus. Fraximus sporadic peaks. Hazel initial decline mid-zone peak then decline. Ericaceae makes very substantial rises,Gramineae increases throughout peaking just before Gramineae dramatically decline at zone boundary.
110		Very substantial Plantago peak and Betula peak. Ericaceae peak. Oak, Alder and Elm low.
110-85		Birch decreases initially then increases peaking at 85 cm Oak declines in two peaks declining severely at 85 cm. horizon. Alder generally increases mid-zone then declines rapidly. Fraxinus increases through the zone peaking just before the 85 cm horizon. Elm reappears and then maintains a consistent presence. Hazel declines steadily. Ericaceae sporadically declines. Gramineae has mid-zone peak slightly increasing at 85 cm. Sharp decline in total tree pollen and shrub pollen as percentage of T.P.
85		Birch peak, Oak low small plantain peak, Ericaceae low.
85-75		Fall in Plantago , Betula and Ericaceae . Fraxinus increasing .
75-60	C-7	Betula declines , Quercus regenerates . Ericaceae and Gramineae remains low . Corylus declines .
60-45	C-8	Plantago , Ericacea and Gramineae initially rises , then declines as Ulmus rises . Betula declines , Fraxinus expands.
45-20	C-9	Two Plantago peaks , Ulmus initially peaks at first Plantago peak but , declines at second Plantago peak. Gramineae and Ericaceae decline. Net T.A.P. and Corylus decline , relative to T.P. Ericaceae declines .
20-15	C-10	Clearance activity declines. Plantago low , Ericaceae and Gramineae rises . Ruderals , Corylus and arboreal pollen decline relative to T.T.P.
15		Ulmus peak , Plantago low , ruderals increase. Quercus rises . Ericaceae rising sharply .

C-10

15-5 Sharp *Plantago lanceolata* rise from 3 to 15 % T.A.P. with other plantains up to 7 % . Pteridium also peak at same horizon . *Ulmus* recovers slightly at upper boundary . *Quercus* rises sharply initially , but ends only marginally ahead . *Alnus* initially , slow decline but accelerates downwards on boundary . *Betula* follows the completely opposite course to *Alnus* . *Corylus* continues to decline sharply . Ericaceae continues to increase , but to much higher levels . Gramineae climbs slightly but ends virtually unchanged.

5 Plantain rising , *Ulmus* low , ruderals climbing . *Quercus* and *Alnus* declining . Ericaceae climbing steadily .

APPENDIX 10

POLLEN CHARACTERISTICS OF THE ZONES FOR WAUN FACH SOUTH

Depth in cm	Zone	
250-236	S-1	Increases in Corylus, Ericaceae and Gramineae to 242 or 240 cm, then decline down to 235 cm Plantago major-media appears at 236 cm Ulmus fluctuates, high Polypodium at basal cm
234-227	S-2	T. .P. and shrub pollen increase. Plantago major-media coincide with sharp decline in Ulmus to 231 cm Corylus, Gramineae and Ericaceae all decline. T. .P. high at 227 cm
227-214	S-3	Slow reduction in T.T.P. and herbs. Largest peak in Corylus pollen in profile at 215 cm Selective Ulmus clearance at 215 to 214 cm, coinciding with first appearance of Plantago lanceolata.
214-205	S-4	Ulmus regeneration phase (211 - 208) occurs before renew and increased clearances shown by Plantago lanceolata peak and Ulmus decline at 204 cms. Fraxinus succeeds Betula. Tilia is selectively cleared. Pinus stable, sharp rise in Ericaceae and Gramineae at Plantago 214 cm peak.
205-201		Elm peaks. Total tree pollen as percentage of T.P. peaks. S.T.P. low and H.T.P. high as percentage of T.P. Birch low, Oak peaks, Alder depression (but still over 50% T.A.P.). Hazel lowest level from base. Ericaceae peaks, Gramineae declines.
201		Elm peak, Birch low, Oak peam, Alder down. Ericaceae peaks. Gramineae declining, Hazel very low.
201-193	S-5a	Elm decline and recover. Plantain reappears. Alder has mid-zone peak then declines at 193 cm Oak declines then peaks at 193 cm Birch and Hazel increasing. Ericaceae peaks and Gramineae increases. Increase in Ruderals.
193		Elm peak Plantago lanceolata increases with Pteridium. Birch and Hazel increase. Oak peak, Alder low.
193-189		Plantago sp. (Plantago lanceolata and Plantago major-media) peak. Oak down slightly, Alder peaks, Birch and Hazel peak, all at 189 cm Ericaceae declines sharply Gramineae climbs sharply and peak at 189 cm.

189 Plantago lanceolata and Plantago major-media peak. Birch peaks. Gramineae peaks, significant depression in total tree pollen and total shrub pollen as percentage of T.P.

189-177 This period show a slow partial regeneration of Elm, 6% on upper boundary with no plantain and low ruderals. Hazel, Birch and Alder also increase on the upper boundary horizon with the reduction of Oak. Pine and Lime are not recorded at all in this portion of diagram.

S-5a

Gramineae and Pteridium reduce sharply in this zone but Ericaceae reaches more than three times higher than at start of zone.

177 Elm peak Oak low, Alder peak. Increasing Birch, Ericaceae peak, Shrubs and Gramineae declining. Total tree pollen and total shrub pollen depressed as percentage T.A.P.

177-173 Birch increases and peaks. Elm decreases, Oak increases, Alder decreases. Hazel and Ericaceae decreases and Gramineae dips to a low. Total tree pollen and total shrub pollen increases and total herb pollen decrease as percentage T.P. Plantain recovers.

173 Birch peaks, Elm low, Plantago regenerates, Oak increases, Alder decreases. Gramineae depression Ericaceae depressed.

173-167 Birch declines rapidly to a low, Pine reappears, Elm peaks, Plantago declines, Oak low, Alder peak, Fraxinus peaks. Hazel increases rapidly. Ericaceae climbs to highest peak. Gramineae low.

S-5b

167 Ulmus peaks, Plantain absent. Betula low , Alnus peak. Corylus high, Ericaceae peaks and Gramineae very low.

167-159 Betula sharply rises , Fraxinus declines , Ulmus declines as Plantago increases . Gramineae low , Ericaceae sharply declines with Corylus .

159-155 Increase in clearance activity , Gramineae and Plantago increase . Corylus continues to decline . T. .P. increases slightly .

155 Plantago increases and peaks. Elm not represented. Birch and Oak low, Alder peak. Fraxinus depressed.

S-6a

155-140 Elm recovers to 6% and Plantago lancealata and Plantago major-media, Pteridium also peak on the upper horizon. Oak has also risen. Birch has fallen. Hazel and Alder remained fairly stable. Fraximus has continued to decline. Lime reappears 2% T.A.P. Both Ericaceae and Gramineae have risen moderately.

140 Elm peaks and Plantago lancealata, major-media peaks also. Birch low, Hazel stable. Oak and Alder peaks. Fraxinus declining Ericaceae decreasing, Gramineae increasing.

140-120	Rapid rise in Plantains peaking at 120 cm Partial regeneration of Elm but declining at 120 cm Oak increasing, peaking just before plantain peak. Alder declining steadily. Reoccurrence of Fraxinus peaking with Plantago. Birch sporadically increasing Hazel sporadically decreasing. Ericaceae peaks just before main Plantain peak. Gramineae peaks on Plantain peak. Significant decrease in total tree pollen and total shrub pollen as percentage T.P.
120	Plantains peak, Birch and Oak increasing, Hazel and Alder decreasing. Gramineae peaking, Gramineae and Cereal peak.
120-115	Elm regenerates partially and peaks. Pine and Birch peaks, Oak and Alder low. Ericaceae increasing, Gramineae decreasing.
115	Elm and Pine peak, Plantago decreasing, Oak and Alder depressions. Ericaceae low. Gramineae decreasing.
115-105 S-6b	Plantago increasing and peaks at 105 cm Alder and Oak increases and peaks at 105 cm Elm decreasing to low at 105 cm, Birch declining sharply Birch mid-zone peak then declining. Ericaceae and Gramineae increasing and peaking at 105 cm. Cereals increase.
105	Plantago peak, Elm low, Gramineae and Ericaceae peaks. Oak and Alder peak.
105-100	Elm regenerates, plantago declines. Oak declines sharply, Alder declines, Hazel rises slightly and Birch rises sharply. Ericaceae drops slightly but Gramineae falls very dramatically.
100	Elm peak falling Plantain. Oak and Alder declining, Birch rising, Ericaceae peak and Gramineae declines sharply.
100-90	Birch rises and peaks plantago sp. fades. Alder and Oak declining slightly. Ericaceae and Gramineae continue to fade, Hazel peaks.
90	Birch and Hazel peak, Alder and Oak falling. Ericaceae and Gramineae continue to fade. Total tree pollen peak as percentage T.P.
90-70 S-7	Birch declines, Oak increases slightly. Alder initially increases then declines. Plantago unchanged. Elm not recorded. Pine increases then declines. Ruderals increase at 70 cm Gramineae increases. Hazel and Ericaceae initially increases then declines.
70	Total tree pollen as percentage ofT.P. low. Gramineae increasing, Alder and Oak increasing, Ruderals peak.

70-50 Elm reappears and peaks. *Plantago* increases then peaks. Alder declines , Hazel initially peaks but declines rapidly . Gramineae decreases . Ericaceae increases then declines . *Fraxinus* reappears .

50 Elm and *Plantago sp.* peak . Oak increases , Alder decreases , *Fraxinus* reappears .

50-40 *Ulmus* , *Betula* and *Corylus* decline . *Plantago* reduces slightly , with Gramineae increasing . *Pinus* re - generates to highest T.A.P. on profile .

S.8

40-22 Clearance activity decreases with *Plantago lanceolata* declining . Some *Betula* trees and few ruderals . *Ulmus* regenerates and *Fraxinus* replacing .

S.9

22 *Ulmus* peak , Plantain low , *Betula* peak . *Quercus* low , *Alnus* peak . T.A P. peak as percentage of T.P.

22-6 Plantain makes sharp large increases together with sharp increase in *Quercus* . *Alnus* climbs slowly and Pinus attains its highest level for the profile . *Betula* declines slightly overall . The high levels for *Fraxinus* continue through this zone. Both Gramineae and Ericaceae levels rise sharply at the top of this zone.

S.10

6 Plantain , *Betula* , *Pinus* and *Corylus* high . *Quercus* declining , *Alnus* increasing .

APPENDIX 11

POLLEN CHARACTERISTICS OF THE ZONES WAUN FACH NORTH

DEPTH IN CM

N1	230-228	Pinus decreases as Alnus increases. Ulmus unchanged , Corylus very high T.A.P.
N2	227-210	Ulmus and Betula fluctuates together , with Gramineae and herbs . Sharp falls and regeneration in Ulmus .
	210-195	Sharp fall in Ulmus, regenerates , then another Ulmus decline with Plantago present . Betula declines , Gramineae declines . Herbs increase .
	195	Ruderals peak, Lime peak, Elm low, Pine low, Alder increasing Hazel decreasing.
	195-192	Elm decreases to a low,pine still low, small rise in Birch, increase in Oak, Lime declines slightly. Alder increases. Hazel increasing, Gramineae rises slightly.
	192	Low Elm, Birch peak. Oak and Lime low. Alder peak, total tree pollen and total shrub pollen peak as percentage of T.P.
	192-186	Elm increases, Pine peaks, Birch increases, Alder declines, Lime not recorded, Gramineae increases.
N-3	186	Pine peaks, Gramineae peaks, Lime not recorded, Elm high. Alder decreasing; Ericaceae relatively high.
	180	Elm and Pine low, Birch high, Oak peak, Lime low, Alder increasing, Hazel low. Ericaceae and Gramineae decreasing, Total tree pollen peaks as percentage T.P.
	180-175	Increase and peaking of Elm increase and peak in Pine as well as Lime. Decrease in Birch, decrease in Oak. Increase in Alder. Increase and peak in Hazel, decrease in Gramineae .
	175	Elm, Lime, Hazel and Pine peak with Alnus rising. Total tree pollen and total shrub pollen low as percentage of T.P.
N-4	175-165	Sharp decrease in Elm reappearance of Plantago declining Lime and Pine. Continued increase in Alder. Birch slightly increase Hazel declines then increase, increase and peak in Gramineae .
	165	Peak in total Ruderal pollen as percentage of T.P. low in Elm, Pine and Lime; Alder increase.
	165-155	Increase in Elm, Pine, Alder and Lime pollen; decrease in Birch and Oak pollen. Increase in Hazel, decrease in Gramineae reappearance of Plantago.

155 Peak in Elm, Pine, Alder and Lime. Increase in Hazel, decline in Gramineae .

155-145 Decrease in Elm, Birch, Pine and Lime; increase in Alder and Oak; both peak at 145 cm Hazel decreases. Ericaceae decreases slightly. Gramineae increases. Ruderals increase and peak at 145 cm

N-4

145 Elm, Birch, Pine and Lime decreased. Alder and Oak both peak at 145 cm. horizon. Ruderals peak also.

145-135 Elm slowly increasing to a peak at 135 cm a mid-zone peak in Lime then decreasing. Oak steadily decreasing. Alder decreases then climbs. *Plantago lanceolata* reappears at 135 cm horizon. Ericaceae increases but Gramineae decreases. Hazel sharply increases throughout.

135 *Plantago* reappears, Hazel peak, Alder increasing, Elm peaks, Oak decreasing, Gramineae peak.

135-130 Dramatic fall in Elm, lesser falls in Lime and Oak, Birch increases sharply and Alder continues to rise, Hazel falls sharply. Ericaceae and Gramineae have slightly declining levels.

N-5

130 Deep low in Elm, peak in Birch, falling Lime, Oak and Hazel, Herbs. Low plantains present.

130-120 Elm regenerates, peaks then falls; Hazel and Lime decline steadily throughout. Oak has a mid-zone peak with Elm, and Alder has a mid-zone depression peaking at 120 cm

120 Betula , *Tilia* and *Quercus* low. *Ulmus* declining , *Corylus* increases , Gramineae increase , ruderals peak.

120-110 *Betula* increases , *Ulmus* increases and peaks. *Quercus* declines , *Tilia* declines and *Alnus* increases and peaks at 110 cm Gramineae climbs steadily. Ruderals low , *Corylus* stable .

110 *Ulmus* peaks , *Betula* increases , *Quercus* and *Tilia* decline, *Alnus* increases , Gramineae peaks .

110-105 *Ulmus* decreases to a low , *Plantago* unchanged , *Corylus* and *Betula* increase and peak . *Tilia* declines then regenerates . *Quercus* is unchanged and so is *Alnus* .

105 *Betula* peaks , *Ulmus* depression , *Quercus* low , *Alnus* high . *Corylus* high , Gramineae low .

105-100 Plantago peak at 100 cm Oak peak Alder low, Lime low, Pine peak. Ruderals peak. Gramineae peak. Birch declining.

100 Gramineae peak, Hazel low, Birch declining, Elm increasing, Quercus peak, Alder low, Ruderals peak,

100-75 Elm increases and peak at 75 cm Birch decreases then increases. Oak fluctuates but decreases regularly; Alder increases but decreases at Elm peak, Hazel gradually declining then dropping sharply at 75 cm sharp decrease in Gramineae . Sharp increase in Ericaceae at 75 cm Plantago low.

N-5

75 Elm peak, Birch Increases, Plantago low, Oak peak, Alder low. Ericaceae increase sharply, Gramineae drops sharply. Total tree pollen rises sharply, shrubs low.

75-65 Elm decline and peaks, plantago increases and peaks, mid-zone peak Alder increases and peaks. Mid-zone Ericaceae peak then declines. Increase in Gramineae .

65 Plantago peak, Oak and Alder peak, Birch decline, Hazel decreasing. Ericaceae low, Gramineae increasing, Plantago increasing.

65-60 Elm recovers slightly, Birch increases dramatically, Oak continues to peak, Alder declines rapidly, sharp decrease in Hazel. Increasing Ericaceae and Gramineae .

N-6

60 Peak in Birch, peak in Oak, depression in Alder, increasing Ericaceae and Gramineae depression in Hazel, depression in total tree pollen and total shrub pollen as percentage T.P.

60-50 Increase in Plantago and high peak at 50 cm horizon, slightly increase in Elm levels, decline in Birch levels,decline in Oak with low at 50 cm , sharp increase in Alder, Alder peaking at 50 cm sharp increase in both Ericaceae and Gramineae.

50-40 Plantago declining , with Ulmus rising . Betula increases with Ericaceae and Gramineae . Corylus declining , and T.T.P. increases .

N-7

40-30 Plantago increases and Ulmus , Betula decreases . Gramineae and Corylus decrease , while Pinus is regenerated at 30 cm

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